PROCEEDINGS OF THE

SUGAR BEET MEETING

HELD BY

THE FARMERS' INSTITUTE

OF DODGE COUNTY.

AT THE CITY OF FREMONT, NEB.

ON FRIDAY, MARCH 15, 1901.

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FACTORY OF THE STANDARD SUGAR BEET COMPANY AT LEAVITT, NEB.

PROCEEDINGS.

The Farmers' Beet Sugar Institute was called to order at the Court House at Fremont, Nebraska, March 15th, 1901, at 9:30 A. M., by Mr. J. J. Hawthorne, who was chosen chairman in the absence of Mr. W. G. Whitmore.

Mr. P. G. Holden, of Pekin, Illinois, had stated his inability to be present at the meeting, but that he would send a paper to be read on the "Best Methods of Preparing Soil for a Beet Crop." This had not arrived, and being first on the program it was suggested that a general discussion should take place on the benefits of the sugar beet industry to Fremont or any other community.

Mr. W. W. Blackman was called upon to state his experience, which he did readily, and in an interesting manner. He had planted beets in only one year, 1900; and had raised one and a half acres, for which he hired all the labor, teams, machinery, etc., paying regular wages to all who were employed in the field. He had charged rental for the land and interest on the money invested from the time beets were planted until he received his check from the sugar company. On this acreage he had made a profit of $18.75. Mr. Blackman considered this a very good showing, taking into consideration that he had no family to do the work and that he was compelled to pay regular wages for everything. He advocated hiring boys for the field work.

Prof. T. L. Lyon, of the University of Nebraska, then spoke as follows on the benefits of a beet crop to a community:

"It seems to me that we are in this country just beginning to feel the effects of the sugar beet industry. The effect is more strongly noted in Germany than in any other community. There the industry is an institution. It is one of the things upon which the government relies as a great source of income. Those of you who have been in Germany and perhaps interested in the business there know to what extent the average community depends upon it.

"All through that country you will find communities of 3,000 and 4,000 people built up entirely on sugar beets. A

little town called Roitz, about fifteen miles from Halle, has a population of about 3,000 people, whose only resource is the sugar beet industry. Upon every side are the farms of those who are occupied in raising beets for the factory. Every man, woman and child is interested in it, and the reason for the existence of the town has been almost solely for that. The people live together in this community—the houses close together—and they have all the advantages of a town. Instead of the farms being large and isolated they are small and close together. Also the advantages for social enjoyment are very great where people are gathered together in communities. This little town is very prosperous and the people appear to be more than usually haypy. While I was there they had a dance, and it seemed to me that every one in the community turned out and that they possessed every means for enjoying themselves.

"The importance of the industry in Germany is further evidenced by the fact that the government has so arranged that it is protected. The consequence is that the business has grown wonderfully. There are in Germany sufficient sugar factories to supply not only the demand for sugar of that entire country, but twice as much besides, a great deal of which we get here in this country. The building up of communities seem to be one of the most interesting features of the whole industry. It certainly indicates the possibilities in the centralization of people into communities and giving the non-landowning population an opportunity to enjoy the privileges that go with community interests that could be obtained in no other way. It will probably be a long time before the business in this country reaches large dimensions, but I do not doubt that we are getting ready for such a state of affairs, and the time is not far distant when our rural population will be gathered together in communities where they will be able to enjoy the privileges that grow therefrom."

Mr. H. Scilley referred to Mr. Blackman's experience with his beet crop and used it as an illustration of the benefit to be derived by labor from this industry. Mr. Blackman expended $60 on one and a half acres, the greater portion of which had gone to labor. We judge of the value of an investment by the amount of interest that it pays. Take Mr. Blackman's statement as a standard. He made $12 an acre. The average man thinks he has done

well if he makes six per cent. On this basis land would be worth $200 an acre; if we take eight per cent interest, we have the value of the land at $150 an acre. It is only a question of time when land will rise in value in proportion to the amount of interest on the investment. A short time ago land in this vicinity rented at $3 an acre, and it is now renting at $5. Formerly it was valued at $35 to $40 an acre. Now land lying six miles from a railway has risen to $50 or $60. The sugar beet industry benefits the laboring classes, but not at the expense of those investing money. Business greatly increases the population of a district. The sugar beet industry enables a man with a large family to work for himself, as he can rent land and use his own family to do the work. His wages are profit, and consequently when the average man gets ten, twelve or fifteen acres of land of his own he is independent.

Mr. R. M. Allen, general manager of the Standard Cattle Company, then spoke as follows:

"Coming back to the point of a community. If I have anything to say today it is on this topic. The paper I have prepared to read deals more on that point than any other. Mr. Lyon has given us a very interesting view of the value of sugar production in Germany, and as we know it has become so important a part of their agriculture that it is firmly rooted in these countries. The industry in France, Germany and Austria is of so great importance that its injury through the successful competition of cane sugar, or from any other source, is regarded with a sort of terror and as something they would not be able to endure. This shows how important it has become today. In this country, as Mr. Lyon says, there are no important communities built up by beet sugar, but certain districts can be mentioned where it may be said to be important, and perhaps one whole state. The eastern part of Michigan furnishes a very good example of the real importance of beet growing, although they have only been grown there three years, not nearly as long as in Nebraska; but it furnishes an example of a district where the industry has become important.

"On the 8th of January I was at a beet sugar meeting at Detroit, and naturally got into conversation with people from different parts of Michigan. The factory at Marine City had a little difficulty in the earlier part of the season,

but it has since got into good working order. All the rest of the factories are doing exceedingly well. At Bay City the season has been most successful and the town has greatly increased in size, as it would anywhere in this country where there was a mining district, or where any valuable activity is taking place which insures a profit The same thing is practically taking place in Colorado. The two factories in the Arkansas Valley east of Pueblo, that of Grand Junction in Western Colorado, and that at Loveland, have an excellent future I believe. The country there for many years has been in a very good state of cultivation.

"We have hardly discovered the benefits to be obtained from the sugar industry in Nebraska, as its progress has been so irregular. During the years 1896,' 1897 and 1898 we had good conditions, but since that time we have had political and other disturbances with which to contend.

"I should have spoken of Utah. There the industry is in an entirely satisfactory condition, and its value to these communities has been demonstrated very clearly. In Michigan and Utah the size of farms and the distribution of the land are very favorable for sugar production, as I shall suggest in my paper. The sugar beet industry is the only one so far as I know that furnishes labor for families.

"We should disburse at our factory at Ames from $250.000 to $300,000 for beets in each year, which amount would be distributed in the immediate vicinity. My judgment as to the value of farming lands is entirely of a country like ours lying west of the Missouri river. I am positively certain that I have never seen so fertile a district as our own. This land is still owned in large blocks. In fact there are large blocks of land that have not been in cultivation—not because the fertility of the land has been questioned, but because the drainage has been so inadequate that the people felt it was a risk to plant crops where they might be injured by water. Everything here is getting ready for the subdivision of farms, and it will come about gradually."

PROPER TIME TO PLANT BEETS AND DEPTH AND MANNER OF PLANTING AS AFFECTED BY THE NATURE OF THE SOIL, BY J. SCILLEY.

The time for planting beets varies considerably, as one has to be governed by the conditions of the weather. One year it might do to commence the 15th of April, while another year it would be necessary to wait until the 1st of May. A great deal too depends upon the acreage one wishes to plant, and the amount of help obtainable to care for beets after they come up. For instance, if one has to hire all his help and there is plenty of help available, it would be best to plant from the 1st to the 12th of May, as it does not cost any more to do the work at one time than another provided weather conditions are the same. I believe it is easier to get a good stand about this time than earlier or later. Earlier the ground is cold, and later the heat of the sun after a rain forms a crust on the ground, making it impossible for the plant to get through; and sometimes forming a steam that entirely destroys the plant. If one wishes to take care of beets with his own family, or is limited to a certain amount of help, then I would say commence from the 15th to the 20th of April. Use eighteen to twenty pounds of seed so that a good stand will be secured, as one plant aids another in coming through the ground, especially if a crust be formed. Plant a few at a time—about a week apart. In this way one can take care of a large acreage—by commencing say the 20th of April and finishing May 30th. Early planting should always be done on land that is perfectly clean or free from weeds. If the land is foul, the weeds will grow before the beets, and it will therefore be very difficult and expensive to keep beets clean, if not altogether impossible. However, when one wishes to grow several hundred acres, it is best to commence as early as the ground is in proper condition, as I believe beets that are planted before the 15th of May are best. One will get in most instances a larger tonnage and a richer beet, and harvesting can generally be commenced earlier, which is in itself an advantage which one cannot afford to lose sight of. Taking all this into consideration, I would say that the best time to plant beets is from the 20th day of April to the 15th day of May.

The depth of planting is governed also by the date of

planting; and also by the kind of soil on which one is planting. For instance, beets that are planted on the 30th of April will necessarily have to be planted shallower than beets planted on the 12th of May, because the ground being cold and heavy in April, if one plants too deep and a big rain follows, the beet will not be able to come through. In most cases the air is shut out and consequently seed will simply rot. Therefore on heavy land in April or the early part of May I should say that half an inch would be the proper depth. Later on in the season when the ground becomes dry an inch deep will answer on light soil, while three-quarters will be proper on heavier soil. It is always better to plant shallow and take some chances on getting moisture than to plant too deep and then have to replant after a big rain, possibly causing a delay of six or ten days, and extra expense in soil preparation.

The ground should first be cleared of all trash that would interfere in any way with cultivation—if heavy land an extra effort should be made to have it fall plowed at a depth of twelve to fourteen inches; if lighter soil it will not be necessary to plow quite so deep, and it can therefore be done in the spring. Heavy land must not be plowed too deep in the spring, but a subsoiler used in connection with the plow to get the ground loosened up to the proper depth. In all cases where land is plowed for beets in the spring, the harrow must follow the plow to prevent the ground from baking, and to get a proper seed bed. It is also desirable to plow just as soon as the frost is out in the spring so that the land will have an opportunity to become compact and be better able to resist dry weather and hold moisture. Too much work cannot be done on the seed bed, as I believe half the attending of the crop can be done before the beets are planted. Therefore I would advise harrowing frequently to kill the weeds on the one hand, and to encourage weeds to sprout on the other; then pulverize thoroughly and harrow before planting and there will not be many weeds left. One must roll once both to pack the soil and also to break little lumps and get the land as fine as possible; then follow with a little light harrow. Sometimes it will be found necessary to roll, then follow with a heavy harrow; then roll again and follow with a light harrow in order to get the ground into proper condition. In light or loose soil the Campbell sub-soil packer is an excel-

lent implement for packing the ground. It is very essential to have the ground or seed bed solid in light soil. Otherwise, seed will in some places be too deep and in others too shallow; and where an uneven stand comes, it bothers and retards the work and in most instances causes more hand work and consequently more expense. It is also desirable to plow opposite to the way one wishes to plant, as it leaves the ground more even for the seeder and is much easier to get the seed all covered. Then one can do a great deal better work with the cultivator. The smoother one gets the seed bed the less hoeing will be required, and the better stand will be secured and a better tonnage with higher sugar content harvested. Therefore I contend that a great deal of success or failure of a beet crop depends upon the manner in which the planting is done.

Mr. J. McGaughey introduced the discussion of Mr. J. Scilley's paper by giving a portion of his experience last season on the farm of the Standard Cattle Company, where he had the oversight of four hundred acres of beets. He concurred fully with Mr. Scilley as to the depth of planting and advised persistent harrowing.

Mr. Lyon evoked a pleasant discussion by asking an opinion as to the direction in which rows of beets should be planted. Mr. Scilley advocated east and west planting, basing his idea upon the fact that most of the winds come from the south, and if given an opportunity to sweep directly down the rows, many plants would be destroyed. In addition to this, the heavy rains from the south have a tendency to pile up dirt around the plants and protect them; whereas if allowed to follow the rows, many of them would be washed away. In case of a dry time when the sand is blowing, if beets are planted east and west, by plowing every three or four rows this difficulty can be overcome. Besides this, by east and west planting much work and expense are saved at harvest time, as people engaged in siloing can follow directly after the toppers, thereby overcoming the necessity for hauling the beets and permitting those who are siloing to keep practically even with the toppers. There can be no question as to the advisability of east and west siloing. If siloed north and south, both sides have to be covered alike, while from silos running east and west the dirt being loose on the side toward the south, beets can be taken out more easily and it is not necessary to cover that side so heavily.

As to time of planting, if land has been properly cared for the preceding fall, there can be no argument in favor of late planting. Plants should have an opportunity to get through the ground before the hot sun of June. By early plantings Mr. Scilley explained that he referred to beets that are planted before May 1st and by late plantings those that are planted after May 20th. Mr. Lyon's inquiry as to whether anyone had experienced trouble from late frosts was answered by Mr. Allen, who stated that on May 21, 1894, there was a very severe frost in this section which damaged corn. Beets were from three to five inches high. The contrast was very noticeable Other crops were injured far more than beets, which endured the frost very well. It is impossible to say what would be best always. In 1893 the Cattle Company began planting beets April 13th. Mr. Hiltner stated that experience at Lincoln shows that irrespective of years beets mature the first or second week in October. The maximum quality of beet develops at that time, as to the sugar content and purity. After that time, especially if rain comes, the quality of the beet begins to drop off. In other words it matures from the 6th to the 15th of October. It requires five months for beets to fully develop, which fully demonstrates the fact that they should be planted early—about the 1st of May, or a little before—in this part of the state and also further south. Mr. Lyon suggested that without doubt it is desirable to plant beets as early as possible in order that they may mature in time for an early harvest, the only question being whether or not the ground is in a condition of warmth to allow the seed to germinate. In determining the time of planting the grade of soil is of very great importance. The sandy soil warms up earlier and therefore admits of earlier planting than the heavier soils.

The necessity for the rotation of crops was well illustrated by Mr. Lyon, who stated briefly an experience of the Experiment Station last season with two patches of beets, each of which was subjected to the same conditions as to soil, time of planting, etc., the only difference being that one field had been in beets the preceeding year and the other had never been planted to beets. About August 1st leaf spot disease began to show itself on the field that had been in beets before, and it spread rapidly until about September 1st, when the foliage was almost completely de-

stroyed. The other field showed very little sign of the disease, and when harvested yielded three and a half tons to the acre more beets, which tested on the average one and a half per cent higher than beets from the field that had been in beets. The effect of rotation on the general health of the crop appear to be of very great importance, and where there is as much land as there is in this state there is no temptation to evade it; and certainly not where the crop is liable to be attacked by any fungus disease or possibly by insects. As to the effect on the fertility of the soil, this is a very difficult matter to determine in dealing with Nebraska soil, as experiments for the purpose of exhausting the soil would be exceedingly irksome.

Mr Scilley stated that his experience in planting corn after beets had been most favorable, and that while possibly the Standard Cattle Company used more fertilizer than others in this vicinity, last year it secured a heavier yield of corn from fields that had been in beets the preceding year than after other crops.

CULTIVATION, WHEN IT SHOULD BEGIN AND WHEN IT SHOULD END, BY H. SCILLEY.

H. Scilley, agriculturist for the Standard Beet Sugar Co. at Leavitt, read this paper entitled, "Cultivation; When it Should Begin and When to End."

In beet culture, as in everything else, it is hard to lay down any hard and fast rule that can be abided by, local conditions of soil, climate, etc., often throwing a person on his own judgment about what is the best thing to do. Growers should, however, always bear in mind the fact that it is much easier to keep weeds from starting than it is to kill them after they have got started. It is also true that every fresh growth of weeds, even if they are killed out afterwards, takes plant food from the soil that should go to the crop, thereby affecting the yield in both quality and quantity, and the extra cost of killing the weeds makes the expense of growing the crop too heavy in proportion to the amount produced.

Bearing these things in mind, therefore, it stands to reason that the horse cultivation should start at the earliest date possible after the seed has been planted. If the beets have been planted early, when the earth is yet cold, and

when germination is naturally slower, it is really a good plan to run over the field with your cultivator before the beets come up, following the press wheel marks left by the drill, and using the flat knives. If a heavy rain packs the soil right after planting, and forms a crust on the surface, the spider wheels will be found very serviceable in breaking the crust, provided it is possible to follow the press wheel marks. If it is not possible to do so, and the seed is not yet sprouted, then use a light harrow with the teeth well slanted back and harrow cross-wise of the rows.

As soon as the beets get up so that it is possible to follow the row, go through again with the cultivator, using the knife attachments in front, and the goose foot shovels in the middle of the centres, on the back beam, getting as close to the row of beets as possible. This covers all the ground between the rows, and prevents any weeds from getting started until your beets are big enough to bunch, though it may possibly be necessary to run through with the cultivator once more before bunching. After the beets have been bunched and thinned they should be cultivated again, this time deeper than before. For this cultivation it is best to use what are called the "bull tongue" shovels on the front beam on each side of the row, and if your cultivator is arranged so you can put on a shield between the shovel and the row of beets, it will admit of your doing better work. Set the shovels as closely as possible to the row of beets, being careful not to disturb the roots of the plants, and use the goose-foot shovels on the back beam, as before, to cultivate the centres. Arrange your shovels so as to leave the ground as level as possible after each cultivation.

From now on it is not possible to lay down any particular rule about how many cultivations the crop should get, but they should be cultivated often enough to keep the surface soil loose and well mulched, so as to conserve moisture, and in fact draw moisture by capillary attraction from the deeper soil.

The custom in Nebraska is to start the cultivation shallow, and as the plant advances in size continue to go deeper with each successive cultivation, the last cultivation being the deepest of all, gradually keeping a little farther away from the beets. We have had very good results with this method, and have raised heavy tonnages of beets of a good

quality. However, it seems to me that we might improve our methods of cultivation, or rather correct them, so as to admit of increasing both yield and sugar content, if we will take time and think of the nature of the plant we are cultivating. The beet is a deep rooted plant and sends its tap-root down into the ground very rapidly as the plant develops. However, this tap-root does not by any means supply all the nutriment necessary to this development, as it very soon gets down into a soil where the plant food is not so available. It therefore sends out feeders into the surface soil, where the plant food has been rendered available by the action of the air, frost and sunshine; and while the tap-root is down in the deeper soil gathering moisture, etc., the surface rootlets are collecting and conveying to the beet the necessary elements of nutrition to enable it to make a rapid and healthy growth. If by close and deep cultivation we break off these feeders, or so disturb them in the soil that they lose their power to convey the necessary nourishment to the plant, we are certainly interfering with the growth and development of the beet. Therefore, as some practical men claim, would it not be a good plan for us to experiment during the coming season along this line, and do our deep cultivation soon after thinning and gradually go to a lesser depth as the beets increase in size, so that the last cultivation would simply be deep enough to leave a good mulch on the surface? This would be practicable if the soil had been properly prepared, and the soil would be loose enough to admit of the circulation of air, and still be in good condition to hold moisture. I will admit that I have never seen experiments carried out to prove or disprove this theory, but I certainly believe it is worth our consideration.

The cultivation of the crop should continue as long as it is possible to get through the rows of beets without breaking off many of the lower leaves. When the beets commence to cover the ground it will be found that in the morning the leaf stems are very brittle, and will break off very easily if they are disturbed; but in the afternoon, when the sun is shining brightly, the leaves become tougher on account of being slightly wilted, and will slide past the cultivator shovels without being injured. Therefore, in the last cultivation, especially if the ground is foul, making late cultivation necessary, it will be well to wait until the middle of

the forenoon before starting in order to avoid injuring the leaves.

We should bear in mind the fact, that cultivation is not simply to keep down the weeds, though that is the main object, but also to loosen up the ground and admit of the circulation of air in the soil, which is absolutely essential to the proper development of the crop, and at the same time to prevents the evaporation of moisture. It is therefore necessary to cultivate the crop as soon as possible after each heavy rain. By this I do not mean to imply that the beets should be cultivated when the ground is yet muddy or sticky, but as soon as it has dried off sufficiently to admit of the cultivator doing good work.

In land that is sandy, so that the sand separates during a heavy rain, it is of the utmost importance that the cultivator be started at once after each heavy rain, especially when the beets are small, otherwise the sand will blow and seriously damage the plants. It may also be found advisable to cultivate four rows and leave six until the field has been gone over. In this way the rows that are cultivated form a wind-break for the others and prevent the soil or sand from drifting until the surface of the other rows can be roughened in the same manner. Our prevailing winds during the spring and summer are from the south or northwest, so that when such land as above described is used for beets it is better to plant the rows east and west, as it gives a better chance to protect the crop in the manner above described.

In this paper I did not intend to give any specific rules for the shovels or attachments to use during the different stages of the cultivation, as the operator will be able to determine what attachments do the most satisfactory work at each of the various cultivations. Different cultivators are also used, each one having its own special tools, some with a single beam and some with a double beam, so that the judgment of the farmer will be the best guide as to how to equip his cultivator as the work advances. I would, however, emphasize the caution, *be careful that your tools do not interfere with the roots of the plant.* I have known men to cultivate beets with the goose-foot shovels set on each side of the row, and close enough to cut a great many tap-roots, and they then wondered why they did not succeed in raising a good crop.

Many beet growers have thought it advisable to ridge up the row of beets during the last cultivation the same as we do corn, their object being to cover up any small weeds that may be coming up and to cover up the crown of the beet so that there will not be so much to cut off, thereby increasing the tonnage. Experience has proven that this is a mistake. The nature of a sugar beet is to go down into the ground, and if the soil is properly prepared and loose enough it will do this. If they are ridged up the beet will grow up to the top of the ridge, and if we have heavy rains after the beets have been laid by the dirt will be washed or settled down, and will leave a good deal more of the crown exposed than would have been the case had the ground been left level. Then, again, when you ridge your rows you are leaving more of the surface of your field exposed to the rays of the sun and the wind, and the consequence is that the evaporation of moisture will be greater. In fields laid by in this way, after an extended period of dry weather, I have often examined the ridges and have invariably found that there was no moisture until you got down to the level of the ground. I would therefore strongly advise beet growers to practice level cultivation.

In conclusion permit me to say there is no economy in stinting the use of the cultivator. Cultivate often enough to keep all the centres clean and well mulched, and never wait for the weeds to show up green before starting. The drier the weather is the more necessary it is for the ground to be kept well stirred, and your beets will be more easily harvested, be of better quality and yield more tons to the acre in consequence.

The parties who were to discuss Mr. H. Scilley's paper on cultivation were not present at the forenoon meeting, so that a general discussion took place. A clear explanation of the advantage of harrowing cross-wise of the rows was given by Mr. Scilley who stated that by pursuing this course while a tooth of the harrow might occasionally catch a plant and pull it out, this would not interfere seriously with the stand, as there would be a number of plants about it which would mature; but in harrowing lengthwise a tooth of the harrow was liable to pull out plants for several feet or even rods, thereby injuring the stand to an appreciable degree.

Mr. Lyon heartily approved the suggestion that past

methods of cultivation were possibly defective, and stated that it is questionable whether or not deep cultivation is ever necessary. Two years ago an experiment was tried at the Experiment Station with a plot of mulched beets, which received no cultivation at all, and a plot cultivated in the ordinary way. The mulch consisted of about two inches of course sand, which prevented the evaporation of moisture and kept down the weeds, and the beets were better than in the other plot both as to sugar content and tonnage. While this might not serve as a final test, it indicates that such soil as that in which these beets were planted is readily permeable by air so that artificial aeration is not necessary to render it soluble, and that the work goes on naturally. If this case applies universally, it leads us to suppose that the only need of cultivation is to preserve a mulch for the purpose of retaining moisture and to remove the weeds in order to prevent the carrying off of plant life.

Mr. J. Scilley illustrated the necessity of cultivating at different depths by giving his experience of seven years on the farm of the Standard Cattle company, when a hard pan formed about two inches below the surface. He suggested that it might be well to begin with deep cultivation and go less deeper each time, and expressed the determination to try the experiment this year.

SOIL AND CLIMATE OF NEBRASKA IN RELATION TO SUGAR BEET CULTURE, BY PROF. T. L. LYON.

For profitable beet production good soil and favorable climatic conditions are essential. One condition without the other is inadequate. Any community that has these conditions possesses possibilities for the development of the beet sugar industry.

There must be in every community a nearly constant figure representing the cost of raising an acre of beets. This figure will be about the same whether the yield of beets be large or small. In determining whether any region is cabable of profitably producing sugar beets the figure above mentioned must be exceeded by the selling price of the crop by a margin sufficiently large to compare favorably with the profits from an acre of land planted to the crops generally grown in that region. This is the prac-

tical and final test as to whether the climatic and soil conditions of any region are adapted to sugar beet culture.

In Nebraska there have been numerous practical demonstrations of the adaptability of climatic and soil conditions for profitably producing sugar beets. Wherever beets are raised year after year, as they have been in this state, for a period of years; and wherever the acreage has been increasing from year to year, as it has been here, it is a sure indication of the fact that beet production is profitable. People do not raise crops year after year that do not pay.

However, it may be of some interest, and of some use perhaps to discuss the effect of climate and soil on beet production: The climatic conditions that affect the growth o beets are temperature, sunshine and rainfall. I will speak of temperature first because that is the factor in Nebraska conditions most criticised by European competitors. The claim is made that Nebraska is too far south, and that the total temperatures during the growing season are too high for the successful production of sugar beets. Judging from the standpoint of sugar producing communities such as Germany and France furnish, that is true, but the question arises whether their conditions are ideal for sugar production. During the growing months in some of the beet growing portions of Germany the average mean temperature is about seventy. In Nebraska the average mean temperature is something higher than that. Now, then, if the conditions in Germany are ideal for sugar production, Nebraska is too far south, but it seems to me that the experiments that have been carried on in this and other portions of the country and the results that have been obtained indicate that the conditions of America are superior to those of Europe; that it is here that the ideal conditions exist and not in France and Germany. I say therefore the average temperature in Nebraska is somewhat greater than in these beet growing localities in Europe, but this is by no means a final conclusion that the temperature is too high here. Let us examine the climates in portions of this country where sugar beets are successfully grown, and where the industry is firmly established. One of the oldest beet growing communities is that of Chino, California; there the factory has been operating since 1891 and excellent results have been obtained year after year. You will find that in California the total temperatures for the year are very considerably

higher than they are in Nebraska; and not only that, but that the temperatures for the growing months—in fact for the whole period while the beets are in the ground—are higher than in Nebraska. It is true that they plant beets somewhat earlier there than we do here. They put beets in perhaps two months earlier than we do here, and notwithstanding the fact that the temperatures during the first months that beets are in the ground are as high as here, we find that in June and July the average temperatures are higher than in Nebraska, and in August when the beets are ripening the average temperature is several degrees more than at this point. Now this not only indicates that sugar beets can be raised profitably where the total temperatures are higher than in Nebraska, but it also indicates that sugar beets can be raised with profit where the temperatures are higher during the ripening period. It has been claimed that at the time when beets are ripening and when the sugar should be laid up, the temperatures here are up so high as to keep the beets growing, thus preventing maturing at the proper time and preventing the final storing of a maximum quantity of sugar. But if that were the case, would we not find in southern California beets of lower sugar content, where the total temperatures are higher than here? If higher temperatures at harvest time were so injurious, it would show there.

Let us take another region in which the beet sugar industry is growing—central Illinois. I have looked up the reports of Peoria for forty-five years. This is only a short distance from the Pekin factory. I find in looking up these temperatures that the average temperature during June, July and August is just as high as it is here. There is no indication of their giving up the industry on that account.

So far as the claim of high temperatures is concerned, it seems to me that we are certainly on a par with some of the very successful sugar beet producing regions of this country.

As to sunshine: This perhaps is a factor that has never been criticised by European competitors, or by anyone else, but it is certainly one of which Nebraska, as well as other western states can boast. If sugar is condensed sunshine, then a country of sunshine should be a sugar producing country. There is through all this trans-Missouri region as large a number of days during which the sun shines as

there is any other sugar producing region; and if sunshine is essential to the elaboration of sugar in the beet, we surely have that essential here. Certainly as regards that climatic condition, we have in our vast amount of sunshine a very important and valuable aid to beet sugar production.

The third climatic condition to be considered is that of rainfall. In this country beets are being grown under conditions of abundant rainfall in the eastern states; in regions where there is only a limited rainfall, and in regions where irrigation is necessary to supply moisture. It is astonishing to see what results have been obtained by irrigation in sugar beet growing. The great advantage of course to be obtained from irrigation is that water can be supplied at the desired time and that it can be held back whenever it is considered necessary. This enables a grower to get land into good condition for raising beets by irrigating in the spring, or perhaps in the fall of the preceding year, and withholding water at a time of year when it is considered its application would be undesirable. A man who is growing beets under conditions of abundant rainfall, gets it whether it is a benefit or an injury, and he may therefore be handicapped very seriously. It is generally considered injurious to have an abundant rainfall during the fall months, as it is very likely to start a regrowth of beets and occasions a loss of sugar in consequence. From this we have suffered two or three years in Nebraska, and particularly in 1894. On the first of September of that year the average weight of beets at the Experiment Station was about one-third of a pound with a sugar content of twelve per cent. Rain came about the middle of the month starting them to grow. The beet began to increase in size and the sugar content began to fall considerably reaching a sugar content of between eight and nine per cent and an average size of nearly a pound. This shows the effect of rainfall on the increase in tonnage and perhaps the lowering of sugar content, although the sugar may be restored before frost sets in. However, if heavy frost sets in before the beet matures, it interferes with the restoration of the sugar. The sugar beet producer in the most favored regions is always liable to this trouble, and in this respect the man who is growing beets under irrigation possesses an advantage because he can control the moisture at this time. But it seems to me that in this respect Nebraska has an advan-

tage not only over regions of abundant rainfall, but also over the irrigated country because here the rainfall is generally so distributed that it comes during the growing season, and gradually decreases in amount during August and September; and in the fall when the beet is laying up sugar there is very little precipitation and the consequence is that in ordinary years the ripening process is not interfered with and the maximum amount of sugar is elaborated. In Nebraska the moisture is supplied at the right time, without the expense entailed by irrigation. Nature has provided a system similar to that by which irrigation is applied and it is free.

The matter of soil is perhaps of less importance in this discussion than are climatic conditions. Whatever doubts we may have as to Providence distributing water properly, we can have no doubts as to His providing a fertile soil in this region. This is a matter that really needs no discussion in considering the possibilities of Nebraska, as this point has never been brought up against beet growing in this region. Our soil is different from soil in beet growing regions of Europe. In the first place it is new. It has never been exhausted. Prairie grasses have fallen upon the land for ages, and the decomposing matter has become incorporated in the soil. This vegetable matter unites with the mineral matter and makes the latter more soluble and easily taken up by the plant. This enables the Nebraska beet grower to grow beets without fertilizing. This is of course not possible in European countries where nearly as much fertility is put into the soil as is taken out by each crop, so practically they must count upon putting as much into the soil in dollars and cents as is taken out. Even in portions of this country where sugar production has been introduced and carried on successfully the same conditions obtain. In New York the use of fertilizers is general; but in Nebraska the use of commercial fertilizers is unnecessary, unless it might be to hasten the maturity of the crop. It has been suggested that the use of potash and phosphoric acid might hasten the maturity of the beets in this region, and their use has been advocated on that account. However, the experiments that we have carried on have not given us reason to hope that that would be the case. The use of commercial fertilizers has generally resulted in securing a larger yield of beets, but not increasing the percentage of sugar,

and the increase of yield has not been commensurate with the cost of the fertilizers. The use of barn manure gives about the same results as the commercial fertilizers, and the cost of that being much less is an indication that its use is certainly profitable on land. Whether manure is best applied in the same year as the beets are planted, or whether it should be applied in the previous year is not very well ascertained, but certainly the results from experiments indicate that when applied in the same year it produces a larger percentage of beets. There is perhaps some advantage that the older soils in Europe have over Nebraska soils as to purity or the solid matters in the juice. The exhausted soil prevents the beets from taking up as much fertilizing material as it does in the rich prairie soils, and so the juice is more liable to have a high purity. This serves as an advantage, because it is easier to extract a large percentage of sugar than in this country, but as far as its effect on yield is concerned, that would not enter into consideration at all. There s perhaps no reason why Nebraska soil should not be considered the equal of any soil in this country for the production of sugar beets.

As to the general capabilities for sugar production, I think we need only to compare the amount of sugar obtained per acre in this region with the most successful sugar producing regions in this country. Now, we cannot claim for any state in the Union that the entire state is capable of supporting a profitable sugar industry. There must be favored localities in which the industry can thrive, and certain other regions in which the business cannot succeed. Although the climatic conditions might be favorable, there are other conditions, particularly of soil, that would prevent certain localities from engaging in sugar production. For instance, when I speak of soil being adapted to this industry it is considered that very sandy soil and sandy regions are excluded, at least for many years to come. Thus, persons who are fortunate enough to find themselves living in these favored communities certainly ought to be congratulated. Through certain portions of this state conditions seem particularly favorable for sugar beet growing, allowing of high sugar content and an excellent yield per acre, especially the heavy soil in the eastern portion of the state lying along the river valleys. I think perhaps we have made a mistake in trying to produce beets on soil that is too light

and sandy, as experiments show that heavier soils in this region are much better adapted to their production. Where the industry has been attempted in some localities and has not proved profitable, the difficulty has generally been that the soil was too light. Here where the rainfall is not large through a considerable portion of the year, the indications are that crops attain a much better growth on heavy soil.

I have prepared a chart here which shows the sugar production per acre in some of the successful sugar regions in this country where the industry has been carried on for nearly ten years, and compared them with beets grown in this valley. I have taken beets grown at Ames, Nebraska, as I have been able to get very satisfactory reports regarding tonnage and sugar content of beets grown there. The table I have here shows the total sugar produced per acre in each one of these localities. This is found by multiplying the tonnage per acre by the average sugar content of beets. The figures I have used from Chino, California, and those from Utah have been quoted me by Mr. Herbert Myrick in his book called "Sugar." The figures obtained by him from these two points I think indicate the tonnage and yield per acre of beets obtained by the average sugar content of beets as they came in. The figures from Ames I have obtained from a little pamphlet published by the Standard Cattle Company:

AMOUNTS OF CRUDE SUGAR IN BEETS PER ACRE.

Year.....	1891	1892	1893	1894	1895	1896	1898
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Chino, California.	1,888	2,100	3,276	2,748	3,309	....	....
Lehi, Utah.....	2,452	1,534	2,250	2,913	3,116	....	....
Ames, Nebraska		....	3.580	3,019	....	5,740	4,232

These figures are certainly an indication of great sugar producing capabilities in this region. I therefore congratulate you who are fortunate enough to be sugar beet growers in Nebraska.

T. L. LYON.

Nebraska Experiment Station.

Referring to Mr. Lyon's paper, Mr. Allen said: "These figures of course involve both the yield per acre and the sugar content at Ames. As everyone knows the sugar con-

tent in California is high which indicates a low yield per acre of beets for that state. In 1894, the year of great drought, the yield at Ames is a very respectable figure—10 1-10 tons—as this was the worst drought that has ever been known here.

Referring to Mr. Lyon's remarks about our being too far south, it appears that in this country the high temperatures need not be regarded as they have been sometimes in Europe prejudicial to beet growing, as in our district we are sufficiently above sea level and the aridity of the climate is rather great. Where there is great humidity combined with excessive heat, the effect is of course injurious. Our unfortunate experience of the past two years from this trouble is by no means normal. Another point as to our location occurs to me, viz: The growing of beets in Spain, Roumania, Egypt, etc. Mr. Pecha has grown beets in Moravia, Bosnia, Russia and Bohemia, and I would like to have him tell us what he thinks of our relative conditions."

Mr. Pecha replied that he had seen conditions similar to those that prevailed in this country last year in all the countries where he had been engaged in beet culture; and that inasmuch as factories are now being built by German companies in Chili, South America, and the business had been established for some years in Persia, he considered it safe to conclude that Nebraska is by no means situated too far south for successful beet raising. It is a mistake to suppose that the success of Germany or any other country is uninterrupted. Mr. Pecha cited one case that came under his personal observation when factories in portions of Germany closed down and made no attempt to work available beets, because there was not a sufficient amount of sugar in them to make the business a paying one.

BUNCHING AND THINNING, BY O. E. WARTENSLEBEN.

Having chosen the best piece of land procurable, whether it be a heavy clay soil or a light sandy loam, upland or bottom land, rich in plant food, or not, it should be always the aim of the grower to secure the largest possible gain or profit. This does not always mean the least labor, but the best possible returns for a given amount of labor.

With that end in view, the grower has selected his ground. If low it should have proper drainage and not be subject to overflow. We find that there are no bad alkali

spots, nor is it sandy enough to drift. If the ground be poor, he should apply either barnyard manure or commercial fertilizer, for he readily realizes that he cannot take from the soil that which is not there. Also that often times poor soil will produce as heavy a yield, if properly cultivated, as a richer soil that is not so cultivated.

Accordingly the proper preparation and cultivation of the soil are most essential. Deep fall plowing and sub-soiling are required to facilitate the access of snow and rain water. Deeply plowed ground always holds moisture best. The retaining of moisture is of the utmost importance, as we have more or less extended dry spells every season which we have to guard against. Loose soil is also necessary for the proper development of the beet, as it cannot penetrate a hard soil, and another advantage is that frost puts the ground in a condition that we cannot secure by spring plowing.

Then as spring opens up the preparation of the seed bed confronts us. If the ground is fall plowed, it is necessary to destroy the first crop of weeds by stirring the ground as soon as the weed seeds germinate. The season of planting drawing near, the ground should be thoroughly pulverized, harrowed and packed, for these are all essential in securing a good stand. After rolling or packing the surface a light harrow should be run over the ground so as to slightly roughen it. This enables the drill to cover the seed better and will also prevent heavy rains from crusting the soil. If the ground is plowed in the spring, it should be done when it is not too wet, as ground plowed when wet packs and bakes and will not hold moisture; it also makes it impossible to attain that friable condition which is required by the beet. If possible, the ground should be harrowed the same day it is plowed to prevent the formation of clods, which once formed are difficult to destroy, especially on soils of a gumbo nature. Otherwise the preparation of the spring plowed seed bed is the same as that of the fall plowed.

Now comes the selection of the seed and planting. In both great caution must be exercised; first in the selection of seed as to its germinating power and variety, and then that it is planted in the proper condition. In the selection of seed those growing for the factories will experience no trouble, as the factory can afford to furnish only such seeds as will give the best possible yield and the highest sugar

content. The depth the seed is to be planted is largely governed by local conditions, varying from one-quarter to three-quarters of an inch—never exceeding that. If the ground is in a favorable condition, the seed will germinate in about four days. The young plants will put in their appearance four or five days later. As soon as the beets are up and the rows can be plainly discerned they should be cultivated. It is necessary to cultivate at least once previous to bunching.

The proper time for bunching is while the beet is in its four leaf stage, which is usually from two to three weeks after the beets are planted. For this branch of the work an ordinary hoe is used. It requires but little practice to acquire efficiency in bunching. The position least straining on the body while bunching is that which is most natural. If the buncher or operator with the hoe is right handed, he must straddle the row to the left of the one he wishes to bunch. Then placing the blade of the hoe over the right hand row, he assumes a slightly stooping position natural in all work with the hoe. He next places his left hand above, with an over clasp, and the right below, with an under clasp, leaving enough space between the hands to give the necessary striking power. Raising his hoe with an easy swing of about two feet, he lets it descend within one and a half inches to the right of the row and draws it squarely across at a uniform depth of about a half inch. In repeating this operation while moving forward, he leaves a small bunch varying from one to two inches in length.

Beginners will have to watch themselves closely and guard against striking twice in the same space. A good stand can be easily spoiled and a habit thoughtlessly formed of which it is troublesome to break ourselves afterward.

Before discussing the size of implements to use, let us examine the condition of the field; the strength and nature of the soil; the stand, and whether the field is weedy or not. For an ordinary soil, which is in fairly good physical condition, the six-inch hoe should be selected, provided the rows are eighteen inches apart which with a two-inch bunch will give the beet about one square foot of ground from which to draw its nutriment. Experts and practical growers have decided that this gives the best results in sugar content and yield per acre. On the same soil if the rows are sixteen inches apart, the seven-inch hoe would be

advisable; and if the rows are twenty inches apart the five-inch hoe is resorted to. It is not advisable to plant in rows twenty inches apart, as all persons who have had practical experience agree, but yet a great many who grow their first crop will insist upon it, their reason being that the horse in cultivating will destroy the beets, the rows seeming too close together compared with corn, potatoes, and the like. One season usually suffices to correct this error.

When beets are grown on poor soil they may be allowed more space. For instance on soil that will yield thirty-five bushels of corn, where the ordinary yield should be forty-five bushels, provided that previous crops had been properly rotated, the seven-inch hoe can be used with the best results; but if the ground is very rich, as in old feed lots, plowed up clover patches, etc., the five-inch hoe should be used on the eighteen inch row, as this is a preventive against the over growth of the beets.

It happens during dry springs that seed does not come up regularly. This can often be traced to improper preparation of the seed bed. Very likely the ground was not thoroughly pulverized and packed, and then soils vary, some being looser than others. Where the soil had been well packed the seed did not reach sufficient depth to receive enough moisture to sprout, while where it was looser the drill placed it at a depth that insured a rapid germination. A case of this kind causes great inconvenience, for it necessitates bunching and thinning twice, it being imperative that the first stand be bunched and thinned when it reaches the proper stage, and it being equally important that the second stand be bunched and thinned, as otherwise the good effect of the first bunching and thinning is entirely lost.

The thinning of the beets should be done as soon as they have sufficiently recovered from the bunching. It is a very serious mistake to allow the plants to become too large before they are thinned. A great deal of care should be used on this point, as there is a tendency where they are growing close together to twine around each other. The principle to be observed in thinning beets is to remove the surplus plants in such a manner as to take all except those intended to ripen, which should be left firm, disturbed as little as possible. This is done best by the thinner, as he crawls along on his hands and knees straddling the rows,

selecting the largest and healthiest plant in the bunch, taking it between his thumb and fore-finger and holding it firmly, while with the fingers of the other hand he grasps the remaining beets, and with a quick movement plucks them from the ground. If the plants are twined about the one that is to remain, the larger these entwining plants become, the more the entwined plants are disturbed. The beets send little feeders or lateral roots very rapidly, and in thinning out the surplus plants, these are very liable to be more or less disturbed. The larger the plant that is to remain the more likelihood there is that it will be disturbed; hence the thinning must be looked after in proper season. Often a damaged plant is set back from ten to twenty days, and frequently numerous plants die altogether when the season is unfavorable. We find also that we have to guard against unnecessary destruction of the required stand. If a beet is exposed, there should be a little earth placed around the roots so that the rays of the sun may not harm it, and also that it may remain firmly planted.

As thinning is the most laborious work in sugar beet growing, we must select labor which will give the best results, and for this we find that boys and girls from eleven to fifteen years old are best adapted, being more active than grown persons. Thinning is more exacting than bunching. While an average buncher will bunch three-fourths of an acre of beets, a good thinner may be able to thin only one-fourth of an acre; but the buncher can greatly reduce the work of the thinner by cutting the bunches down to as few beets as possible. Thorough bunching and thinning are the key to successful beet raising. A poor stand caused by improper bunching and thinning cannot be remedied by thorough cultivation. A large beet may be grown, but it will be inferior in sugar content, and thus be unfitted for the market. It is also essential that thinners should pull all the weeds in the row, as this will very often save hoeing, and it is a great deal easier for the thinner while down on his hands and knees to pull the weeds than it is for the hoer to stop and destroy them.

With all the ingenuity of Americans they have as yet failed to place a machine on the market that will displace the hoe in its domain. Various machines have been made for bunching, but none have been a pronounced success.

Mr. Neastrom's refusal to discuss Mr. Wartensleben's

paper was by Mr. Scilley attributed to undue modesty, as he stated that Mr. Neastrom had raised beets since 1893 that have yielded a satisfactory sugar content and tonnage.

The question as to whether it is best to put dirt around beets after thinning was discussed at some length. Mr. Wartensleben was firmly convinced that this should be done, but the larger portion of experienced beet growers present did not share his opinion. Mr. Scilley stated that if thinning is done at the proper time this custom only entails a useless expenditure of time and money. Mr. Grigereit suggested that in many cases dirt placed around the roots serves to cover weeds that have not been removed.

Mr. H. Scilley at this point reverted to the unfortunate experience of 1894, and inquired if in Mr. Lyon's opinion the effect of the rain late in the season would have been such as it was if the beets had been mature and in normal condition at the time the rain came. Mr. Lyon stated that while rain would in any case probably lessen the sugar for the time being, unless checked by a heavy frost it would be replaced. While a light frost does not interfere, but helps to mature and store sugar; if sugar has been broken down and arrested by a heavy frost no further improvement is made.

SOME CAUSES OF LOW SUGAR CONTENT, BY R. S. HILTNER.

This subject is plainly too broad and far-reaching to be discussed in any one paper that is to an acceptable degree brief. I am constrained to confine myself to a consideration of the commoner and more important points.

The causes of low sugar percentage in beets are numerous. Indeed it would be impossible to enumerate all the causes that give this undesired result. In many cases, in fact in most cases, with a little study and with a few pertinent facts in mind, it is possible to discover what forces have operated to reduce the normal sugar content. But in a few cases we are not permitted to know the reason. Nature has the secret and she keeps it closely—we may simply guess. While studying the causes of low sugar percentage it may be of interest to consider at the same time some of the remedies or some of the means of prevention that have been suggested.

In raising a crop of sugar beets, the farmer is confronted with quite a different set of problems from those which are presented in the culture of other crops. With corn, for ex-

ample, the farmer's chief ambition is to secure a large yield. Toward this goal he bends all his energies, knowing full well that the quality of the grain will take care of itself and is not likely to prove disappointing. Fertilizers are plentifully supplied or the crops are properly rotated in order to insure normal or high yield. The same is true of wheat, of oats, of potatoes and of other crops. With such crops a good yield generally predetermines good quality, simply because what we call a good yield is nothing more nor less than what experience has taught us to be the average product of a normal, healthy growth. A normal, healthy plant will produce good seed, good fruitage. Anything short of normal quantity indicates an abnormal, unhealthy, or hungry condition which will have its effect on the quality.

With sugar beets such rules do not always hold good. The very efforts that are usually put forth to increase the yield of other vegetables will, when applied to beets, frequently though by no means always, work a decided injury to the quality of the product, more especially to the sugar content. That this is true will be admitted by all who have attempted to raise beets; particularly if they have grown them for two or more successive seasons and have compared results. It is a well known fact and a matter of common experience that very large beets are always deficient in sugar. In almost every case it will be found that in beets, grown from the same kind of seed, the sugar content will vary inversely with the weight of the beet where this weight is above the normal or average. The greater the weight the less the percent of sugar, as a rule. This variation is not true where the weight is less than normal. In such cases it is found that the sugar percentage diminishes with the decline in weight.

In order to produce a large crop of any vegetable, it is only necessary, as we all know, to select good seed and then to see to it that the soil, climate and kind of cultivation, to which it is to be subjected, are in accord with the peculiar nature and requirements of that crop and to supply it abundantly with water and proper plant food. With ideal climate and cultural conditions there seems to be a pretty well defined maximum limit to the yield of each and every crop, and it seems, furthermore, that with these ideal conditions we approach these limits more closely in proportion as we supply abundantly and scientifically the proper plant foods.

This applies just as well to sugar beets as to other plants. The more nearly we conform to the natural requirements of the beet as to the character of soil and weather, and kind and quantity of fertilizer, the larger will be the tonnage. Unfortunately, however, for the farmer and for the manufacturer alike, it is necessary to be content with a short crop—at any rate, not a maximum yield—in order to secure the desired sugar percentage. In view of the inverse ratio of weight to sugar in large beets, as explained above, it often becomes necessary to resort to restrictive measures in order to prevent the development of the beets to their full size.

These are the facts in the case as regards the effect of large tonage, but the reasons for it are not so easily told. If in a large beet it were simply a matter of low sugar content and abnormally high percentage of water, as many suppose, the explanation would be quite simple. But such is not the case. A number of experiments made very recently at the University Station by Mr. Thatcher and myself have proved that the difference in water percentage in very large beets from that in very small ones is not great. The maximum range was found to be from 86 per cent. to 80 per cent. It is true to a certain extent, that in such large samples the percentage of water is usually found to be higher than in beets of normal size, but not so high as to account for the large discrepancy in sugar content that is so often noticed. For example, consider only a single set of results of analyses made this year at the Station: two beets grown from the same kind of seed, in the same field and harvested at the same time; one weighed 1115 grams, the other 575 grams. The former contained 9.45 per cent. of sugar and 84.96 per cent. water, while the latter contained 13.05 per cent. sugar and 80.85 per cent. water. If, in the large beet in question, the decline in sugar percentage indicated, had resulted from an excessive amount of water stored up, there would be quite a different ratio of water to sugar from that actually observed. The following figures will make my meaning clear: If we were to add to the beet weighing 575 grams and with 13 05 per cent. sugar enough water to reduce the sugar to 9.45 per cent, we would have to add only 219 grams, making a total weight of 794 grams and a water percentage of 86.1. Or, considered in another light, if it were possible to add water only to the 575 grams beet until it weighed 1115 grams, it would then have 90.1 per cent. water and only 6.7 per cent. sugar.

It is true that I have used only one example in the effort to establish this point. I have done this, however, merely to avoid burdening you with a lot of figures and to avoid making this paper tediously long. An examination of the records of analyses of the Nebraska Station as well as those from other Stations will show that this is but a single illustration of a very general rule. Those of you who are familiar with the usual methods of evaluating beets, will see at once that the above figures simply indicate a difference in purity of the two beets, that is a difference in the ratio of sugar to total solid matter. To use the same analyses as above, the large beet has a purity of 62.8 (9.45:15.04), while the smaller one shows a coefficient of 68.1 (13.05:19.15). Here again one illustration will suffice because all results obtained point to the same thing, namely, large beets show a lower purity than beets of normal size.

Consider briefly the essential composition of beets. They all consist essentially of water and solid matter. Part of the solid matter is soluble in water and part insoluble. The insoluble portion, the marc or pulp, constitutes the cell wall of the beet. The soluble solid matter, consisting of sugar mineral salts or organic matter not sugar, held in solution by the water, constitutes the juice. Experience has taught us that the percentage of marc, of water, and consequently of total solid matter varies only between narrow limits in beets of all grades, rich and poor, large and small, but it has also taught that the composition of the soluble solid matter of the juice is exceedingly variable. The proportion of sugar in the juice, as we all know, is by no means constant. As the per cent. of sugar increases, the per cent. of organic non-sugars decreases and vice versa. In the large beet the sugar percentage is low and we would therefore naturally expect that the organic non-sugars would be high if the above be true, and that the total solid matter would remain a constant factor. Such a condition, as already explained, almost invariably prevails. The facts, always pointing to the same thing, are so persistently forced upon us that we are compelled to accept the truth of them, whether we understand the reason for them or not.

Just why it is that we lose sugar and gain undesirable non-sugars when we grow large sugar beets, has never been, to my knowledge, satisfactorily explained. The reasons for it certainly do not lie very near the surface, a

when one starts to dig for the truth of the matter, it is by no means easy for him to prove that he is on the right lead. In regard to this problem, I have no pet theories to advance and I am riding no hobbies. I have, however, given the matter some thought, and wish to present a few points which may possibly serve as an explanation, or a partial explanation, of the matter in question. I shall be glad if you will consider the suggestions and later discuss the subject fully. We should know, if possible, what the reason for it is, because by knowing it we may be able to govern the conditions and prevent the decline of sugar.

I have chosen to consider this question from a biological standpoint, and wish to deal with the individual beet rather than a large mass of beets or a field of them. The sugar beet is a peculiar plant, perhaps the most peculiar of all the common economic vegetables. It is a highly artificial type; extremely high-bred. With the exception of a few plants like the effulgent chrysanthemum, the sugar beet stands supreme in this respect. It is a most striking illustration of what can be accomplished by careful, scientific culture and seed selection. The sugar beet of to-day, either in form or size, or composition, resembles but little the common garden beet (Beta Vulgaris), to which it is botanically related. It does, however, bear considerably more resemblance to the sugar beets of the less highly cultivated varieties which were grown 75 or 100 years ago. It has about the same average size and weight, the same percentage of marc, and the same percentage of solid matter (possibly a little less of the last) as the beets then had. The modern type has more sugar and less organic non-sugars than had its ancient progenitor. The principal change that has been wrought in the beet by selection and cultivation and breeding has been in the composition of the total soluble solids, i. e., the juice. The percentage of these on an average in the beet is about the same now as in the original stock. The sugar percent in them has apparently been built up at the expense of the other soluble matter. In Napoleon's time, when the manufacture of sugar from the beet was first begun, the solids averaged about 13 or 14 per cent. and the sugar about 5.5 per cent. to 6 per cent, while now a normal beet contains about 17 per cent. to 18 per cent. solids and about 14 to 14.5 per cent. sugar. While the total solids, therefore, have been increased only about

one third, the sugar has been increased about three times. The purity, consequently, has been greatly enlarged; an increase from 42.3 (5.5 : 13) to 80:5 (14.5 : 18), or nearly doubled. It is very evident, therefore, that the artificiality of the sugar beet lies almost entirely in the high sugar content.

As in the case of highly bred types in the animal kingdom there is a liability, if not a tendency, to retrogression, to reversion to the original type. Consequently, even with the choicest of seed, selected with the most scrupulous care, it occasionally happens that an inferior crop will result. The higher the breeding, the more artificial the type, or the farther removed from the original stock, the greater becomes the danger of such reversion. Degeneration in quality is more liable to occur if the soil and meteorological conditions are unfavorable, and if the artificial characteristics have been only newly acquired and not strongly fixed. If, therefore, the beet be subjected to unnatural conditions of any sort, the equilibrium is disturbed and it at once responds by yielding less sugar. Now more to the point in question: The individual sugar beets first studied by Margraff were rather small, but the normal average size of the modern beet is not much larger. In the improvement of the beet, in other words, it has gained very little in size. Consequently in this respect the sugar beet is not an artificial type; a beet weighing 1⅓ to 1⅔ pounds is in its normal, natural state. If now we plant normal seed from one of the highly developed normal-size beets, in a soil that is too rich—particularly in nitrogen—and where the climate is too warm and too wet, we will doubtless get large beets, but the unnatural or abnormal conditions will have worked disastrously on the sugar content. We will get beets of a degenerate quality.

Manifestly it would be a difficult matter to prove whether or not this is really the reason for the low sugar. We have little but circumstantial evidence to cite, but most of the facts observed point plainly in this direction.

It may occur to some that this state of affairs: namely, that sugar content is lowered as the tonnage is raised, is not a wholly unmitigated evil. And it may be urged that large beets of low sugar content may produce as much sugar per acre as small beets with high sugar percentage. Such of course is true, as may be shown by a few figures. Twenty

tons of beets with 7.8 per cent. sugar will contain the same total weight of sugar as twelve tons with 13 per cent. saccharine matter. The two cases, however, should not be considered in the same light. With such extremes, comparative values cannot be figured on the basis of sugar alone. The values will depend considerably on the use to which the beets are to be put. If they are to be fed to stock the larger beets are more valuable, because it has been shown again and again that low grade beets are just about as good for cattle food as high grade beets. The reason for this is, as already explained, that the percentage of total soluble solid matter in the beet, most of which is digestible and nutritious, is quite constant. So that if the per.cent. of sugar is low, the per cent. of other soluble matter, almost equally valuable as food will be found to be correspondingly high. For feeding purposes then, 20 tons of 7.8 per cent. beets are nearly as valuable as 20 tons of 13 per cent. beets.

If, on the other hand, however, the beets are to be used for sugar mnnufacture, the relative value must be figured from wholly different standards. Those with the highest purity always yield the highest percentage of granulated sugar at the factory. Hence such are the most valuable. The reason for this will doubtless be explained by others present. As a general rule, beets with high sugar content show high purity; those with low sugar low purity. It is evident therefore that while 20 tons of 7.8 per cent. beets contain as much sugar as 12 tons of 13 per cent. sugar, the two would not by any means yield the same amounts. To sum up these points, the value of the beets to the stockman depends upon the amounts of sugar and other nutriments that they contain, while to the manufacturer it depends on how much granulated sugar they will yield.

Thus far I have considered only one phase of the subject and have endeavored to emphasize the fact that abnormally high tonnage usually is accompanied with low sugar content and have suggested a possible reason for it. From what has been said the inference must not be drawn that a reciprocal result is produced when the conditions are reversed. It is by no means true that with abnormally low tonnage, the beets show a high sugar content. An examination of the records of analyses of individual beets shows that in the majority of cases the very small beets also are deficient in sugar and also in purity. In such beets there

is but very little less moisture than in beets of normal size, so that the popular impression that such beets have dried out and that woody fibre is developed at the expense of sugar is more or less erroneous. I am inclined to think therefore that the same cause is operative here as with the large beets. It seems to me highly probable that this sort of retrogression gives rise to low grade beets much more frequently than is commonly supposed. Considering these two sets of facts together it seems then that when the weights of the individual beets are far removed, either one way or the other, from the normal natural size, diminution in sugar and purity results.

The practical side of this question is the side that doubtless concerns us all the most. No matter what the cause of these variations may be, the facts are before us and they point very plainly to the path to follow. It is evident that to secure maximum sugar content, the individual beets must be of uniform and normal size. For the modern varieties this normal weight is about 1 ⅓ to 1 ⅔ pounds. To secure such uniformity requires careful adjustment of conditions as to soil, water supply, cultivation, etc., and furthermore a perfect stand. To prevent the individual beets from becoming excessively gross, or diminutive, the distance between rows and between plants will have to be adjusted to suit the character of the soil and climate. It may take two or three years of careful scientific observation and experimentation to get control of the conditions in a certain locality, but the time will certainly be well spent.

With these facts before us in regard to the character of sugar beets in general, we may consider with much more haste, a few other common causes of low sugar content. Those that present themselves most strikingly are as follows: Poor seed; faulty selection and preparation of the land; imperfect stand; unfavorable weather conditions; attacks from plant diseases and insects.

Of all of these the first is the worst and the hardest to combat. The effect of poor seed. The easiest way to account for a bad crop of any sort is to assume that the seed used was of poor quality, i. e., inherently poor, of low grade stock, poorly bred. It is a safe assumption to make because there is little danger of being successfully contradicted. It is a difficult proposition to disprove. The arguments are usually based on certain Darwinian theories in regard to the

effect of heredity. When a boy turns out bad now-a-days, it is not considered his fault entirely. His short-comings are regarded in part at least, as the out-cropping of cussedness inherent in his parents or that was inherent in some of his earlier ancestors. So also with other kinds of beets; those in the vegetable kingdom. If a sugar beet be found, or if a crop of beets be found to be degenerate in quality, particularly if it has been given proper care and proper environment, the seed is blamed or what amounts to about the same, the parent beet or the grand-parent is held responsible. There are of course certain good reasons for such theories. It is a well known and fundamental biological fact that plants as well as animals transmit from one generation to the next, all their essential qualities and characteristics: form, size, color and composition. A sugar beet weighing a pound and a half, having a long, tapering taproot, small crown, large leaf surface, high sugar content and purity, will produce seed which in turn when planted and properly environed will yield other beets of like kind, weight and characteristics. According to the same rule a beet inferior in one or more of these respects will transmit to its progeny these same weaknesses and deficiencies Since all beet seed looks alike, that is to say, since it is impossible to distinguish even by careful examination, good seed (even in these respects) from poor seed, the conditions are wholly beyond the control of the farmer; he is simply at the mercy of the seed grower, or perhaps better at the mercy of the seed. Indeed the seed grower is likely to be just as ignorant of the quality of seed as the farmer. Owing to the artificiality of some of the qualities of the beet, the seed man may plant a high grade mother-beet and find later that the seed is of inferior quality because of some degeneration the plant has suffered, and the effect of this will not be felt until the next crop is mature. The danger from this retrogression in the seed is not as great as formerly and becomes less and less as the artificial qualities become more fixed.

Another biological principle that is pertinent here is that the quality of an organism is affected by its environment. Sometimes the effect is good; sometimes it is bad. With the highly bred organism a change of any sort in its environment, or a disturbance of the natural conditions, will usually result in a deterioration. This principle should

be kept in mind especially as long as we continue to buy our seed in foreign countries. We should not be too hasty to pass judgment on the quality of the foreign seed because, no matter how good the seed may be, the conditions of soil, and weather are often so different from those which prevail in its original habitat as to change materially the quality and habit of the resulting plant.

Second: The next point to which I beg to call your attention is effect on the sugar content of faulty selection and preparation of land. This point need not be fully discussed here. I question if I can add anything to your fund of knowledge on the subject. As a general proposition it may be stated that a soil not adapted to the requirements of this exacting crop will produce low percentage of sugar. The soil best suited to the normal development of beets is rich sandy loam with a porous well-drained subsoil (a good "potato soil"). A shallow soil with a hard, or a water-soaked subsoil is fatal to the crop. An excessively rich soil is to be avoided, especially if rich in nitrogenous matter, because of the tendency to produce a very heavy growth of beet and thus to diminish its content of sugar. On the other hand a poor soil is also to be avoided, since it will yield small individuals and the effect as explained is disastrous to sugar.

The seed bed must be carefully prepared and the subsoil loosened up. Lack of attention to details in this direction may result in gnarly beets with divided roots and large crowns—"freaks" in form. Experience has shown that such beets are deficient in sugar.

Third: An imperfect stand of beets is inimical to sugar content. From what has been said it is not difficult to understand the reason for this. When only a partial stand is secured, the individual beets are often widely separated and tend to become gross and malformed, if the soil is good, with the inevitable result of low sugar factor. An imperfect stand usually results from one of these causes: poor seed, i. e., seed that has become old and spoiled in shipment; next, faulty planting of seed. The tendency is to drill the seed too deep. The young beet plantlet is a tender thing indeed; too delicate and weak to push through more than a thin layer of soil. Three-quarters of an inch is deep enough. The third cause is unfavorable weather after planting, and unfortunately over this we have no control.

Fourth: Unfavorable weather is an important influence for evil with the growing crop. If too wet or too dry, too hot or too cold, the results are liable to be serious as regards tonnage or quality, or both. The beet, however, can stand a good deal of rough weather without suffering. We have no control over these conditions, but there is encouragement in the fact that we can counteract or overcome these untoward conditions by proper treatment of the soil by drainage or irrigation and by cultivation and mulching, as the case may require.

Fifth: Fortunately for the industry in this country we have not had to battle against many diseases nor kill off many insect enemies that attack the beet. Occasionally there has been an outbreak that has made serious inroads into our fields. All of these enemies can be pretty successfully vanquished by known methods. Most of these enemies of the sugar beet attack the leaves, and the effect on the beet therefore is easy to foresee. Destroy the leaves entirely and the plant will stop growing and would soon die. Destroy or injure a part of the leaves and the storing up of sugar will be checked at once. The leaf of the plant corresponds in function to the lungs of an animal. In them the plant breathes and through the respiration and with the intervention of chlorophyl and water and sunlight the carbon of the carbon dioxide in the air is fixed and transformed quite directly into sugar. In the leaves is located the sugar factory of the beet; it is here and here alone that the saccharine matter is elaborated from the simple raw materials contained in the atmosphere. The beet-root itself is simply a store-house in which is deposited the sugar elaborated in the leaves. If, therefore, disease destroys the leaf, if moth and rust the factory destroy, the farmer will find at the end of the season very little sugar in the little underground store-house.

In conclusion allow me to say that in spite of the many conditions that tend to diminish the normal sugar content of beets, man is still master of the situation, and that these obstacles, which after all are really small, are easily surmounted.

Prof. Lyon opened the discussion of Mr. Hiltner's paper and spoke about as follows:

"Mr. Hiltner has given us a very comprehensive view of the causes of low sugar content. He seems to have sug-

gested all with which I am familiar, and I can therefore add nothing on the subject. The one point deserving of particular emphasis is that of the low sugar content occasioned by a poor stand of beets, which I consider above everything else responsible for this unsatisfactory condition. The reasons for this are very manifest. They are inherent in our expensive methods of cultivation. We are farming large areas of land and some persons are apt to undertake the work with a minimum amount of labor. The consequence must be that the preparation of the soil is neglected; the thinning and hoeing are not done as carefully as they should be, and the result is a poor stand of beets. A uniform stand when the beets are growing will result in a uniform size of beets, but if the stand is irregular some beets will be much larger than others. This is especially true in Nebraska, as the soil has a large amount of plant food. For this reason the nature of the soil and methods of work share the responsibility.

It appears to me that the important cause of low sugar content in our beets is one that can be removed, since we see very many examples of beets that have been carefully cultivated where the sugar content is satisfactory. We cannot depend upon Providence to do our farming for us, and we had better look after that matter ourselves and insure a good yield of beets. The large amount of nitrogen in the soil here occasioned by considerable decayed vegetable matter, may possibly cause the low sugar content in beets, if the rainfall continues late in the season, especially if the soil is charged with moisture for a great length of time. In ordinary years this will not be an occasion for great loss of sugar, because generally we have little moisture in the fall. We usually have a great deal of rain in June and July, less in August and still less in September, so that in ordinary years on upland soil the danger of low sugar content arising from excess of nitrogen in the soil is not great."

A rather interesting discussion took place at this point as to whether beets of low sugar content weigh less in proportion to bulk than beets of high sugar content. The experience of last year pointed strongly in this direction, as attested by Mr. Scilley, who stated that the great loss of sugar was contemporaneous with loss of sugar content. Messrs. Lyon and Hiltner were of the opinion that the tonnage was not affected by the diminution of sugar. Mr.

Hiltner added that while the sugar may be transformed by chemical changes into other organic substances, the weight is probably not affected.

STATUS OF NEBRASKA AS A SUGAR PRODUCING STATE, BY R. M. ALLEN.

R. M. Allen, president of Nebraska Sugar Association and vice president of Standard Beet Sugar Co. at Ames, read the following paper on "Status of Nebraska as a Sugar Producing State:"

It is now eleven years since the Grand Island factory, which was the first factory built in the United States after the passage of the McKinley law, began operation. At that time the factory at Alvarado, Cal., was the only one in the country, and it has always been felt that Nebraska took the lead in the recent and modern movement for the production of sugar from beets in the United States. The following year the Norfolk factory was built, and the two factories at Chino and Watsonville, Cal., were completed. This made three factories in California and two in Nebraska, giving Nebraska a very respectable rank, in virtue of which we made the claim, as was quite proper, that she was in the very front rank of sugar producing states.

After a number of years of more or less checkered career Nebraska added a third factory to her list, but unfortunately without an immediate improvement to her standing. Today Michigan leads the entire list with twelve factories and with an aggregate production of fifty-two million pounds of sugar for 1900. California follows with eight factories. Colorado this year will have four and Utah three; then comes Nebraska with three, making Nebraska fifth in the list; New York has two, and Oregon, Wisconsin, Minnesota, Washington, Ohio and Illinois one each. We therefore now find ourselves in the fifth rank, since Utah has a much larger production of sugar than Nebraska. There is really no thoroughly good reason why our relative position should not be much better, though I do not think it important that we should claim that we ought to stand at the very head of the list.

It is not worth while to repeat the story of all the things that have gone wrong in sugar production in this state, but

it may be valuable to understand our conditions of today, and to enquire whether there is any good reason why we should not stand a little further up toward the head of the class.

On some points an argument that might be introduced by this paper is already forestalled by the paper on the climate and soil of Nebraska. In '96, '97 and '98 the results in beet culture were very satisfactory, and the yield of sugar in the factory also. In '99 and 1900 we have been so damaged by an excessive rainfall in August and September that our position in sugar production has distinctly declined—at least relatively. I do not believe there is any adequate reason why this should be so, and for the future I am confident of an improvement. The situation of today is distinctly worse than before the Standard factory was constructed, because beet growers—in what we all believe to be a district of unusual fertility—have suffered from leaf blight, insects, and a general indescribable injury to the beet crop through excessive moisture. The rainfall in August, '99, was the largest rainfall in August on record at Fremont—9.78 inches; that of August, 1900, was the next largest—6.37 inches—with the single exception of the year 1884, when the rainfall was 6.73. Adding August and September together, we have a rainfall at Fremont in 1899 of 10.39 inches; and in 1900 of 11.18, it being heavier in each of these two years than in any year except 1884, when it reached 12.04.

RAINFALL AT FREMONT.

The record of rainfall at Fremont for the months of August and September 1878 to 1900 inclusive was as follows:

Year.	*August.*	*September.*	*Total.*
1878.....	4.92	3.27	8.19
1879.....	3.53	.70	4.23
1880.....	6.06	2.17	8.23
1881.....	.32	3.66	3.98
1882.....	.83	.37	1.20
1883.....	5.15	3.04	8.19
1884.....	6.73	5.81	12.54
1885.....	5.11	1.08	6.19
1886.....	2.77	3.39	6.16
1887.....	3.57	1.69	5.26
1888.....	4.59	.39	4.98
1889.....	2.02	1.40	3.42
1890.....	1.33	2.31	3.64
1891.....	1.27	1.37	2.64
1892.....	2.71	.62	3.33
1893.....	4.51	....	4.51
1894.....	1.04	.46	1.50
1895.....	5.50	1.50	7.00
1896.....	1.50	5.03	6.53
1897.....	2.27	.56	2.83
1898.....	2.06	1.95	4.01
1899.....	9.78	.61	10.39
1900.....	6.37	4.81	11.18
	83.94	46.19	130.13

If it were necessary to look forward to a continuation of such seasons as those of the last two, with excessive rainfall in August and September, I believe I should "throw up the sponge" at once and abandon any further attempt at producing sugar in this state, as neither I nor any other sensible, hard-working persons can afford to waste valuable time upon something that cannot be done. But you will, of course, admit that it is not necessary to look forward to a very frequent recurrence of seasons like the last two. It is very likely also that if the excessive rainfall of August, '99, had not followed so rainy months as those of May and June of that year that it would have been less destructive, as the rainfall of September was very light—only .61 of an inch. Also, I believe that the rainfall of August and September, 1900, 6.37 and 4.81 inches, respectively, would not have been so injurious had not the year previous been so wet. I believe that the water content of the earth under the surface has been in excess of the normal for the last two years.

I trust that this statement is not too full of figures to be easily understood and that my meaning is clear: that our conditions for the last two years, to say the least, have been very unusual, and without tabulating figures at all I know very well that I have never seen such conditions before since I have lived here.

It is a great piece of work to build a sugar factory and to get it finally into thoroughly good running order. I suppose no factory was ever built that proceeded evenly, with perfect operation, from the day of starting, and unfortunately ours has been no exception to this rule. It has, however, passed through its period of probation, and is prepared to operate to its capacity. Not that it has reached a point where it may be left without further improvement, however. There is no doubt that changes and improvements will take place in the future. We hope to secure a supply of purer water for some purposes; also to increase our capacity when the volume of beet growing shall justify. Another point of importance in this immediate district is that we have accomplished much valuable drainage, the completion of the system marking a wide difference between the time anterior to the construction of the Central ditch and the future that will come after it. While this drainage will not accomplish all that is desired for the country east of Fremont, it will help, as I am assured by persons who

have farmed for many years in that vicinity that the drainage up the valley in the case of each new ditch has had a marked effect on the moisture of land east of Fremont.

I daresay that some one is to blame for this combination of bad seasons, unfinished factory, leaf blight, butterflies, etc., that have vexed us the last two years, but it is difficult to fix the responsibility, and in the case of the seasons we shall have to give it up altogether. It is deplorable that beet growers have suffered such ill luck, and I speak with an entirely sympathetic heart, as I am sure that no one has suffered more than I have.

I wish every citizen of Nebraska who is in any way a friend of sugar production here could visit some district at home or abroad where the industry is in thoroughly successful operation in order that he might gain more faith in our future success here; and also acquire an adequate idea of its value.

It is true that at the present time the average size of Nebraska farms is large, and the breeding and fattening of meat animals, particularly swine, to which also belong corn growing, has here so natural and excellent a field that at first sight the conditions of the state do not so urgently call for an industry like sugar production as in some other states. For instance, in Michigan the size of farms is much smaller, those of farmers engaging in beet growing, as I was told in January, running from fifteen to forty acres in size.

On the Arkansas in Colorado the elevation is too great for corn growing while the quality of beets is so extremely good that there appears to be no doubt of the superiority of that section for sugar production. But we must remember that in that portion of Colorado land which may be given to agriculture is more or less confined to the valley of the Arkansas itself. I do not pretend to speak with too much authority on this point because I really have not seen much of that portion of Colorado since the valley was put under irrigation. I do not therefore care to say in too decided a way that there is no area under cultivation away from the river valley. I have, however, passed through there more or less for the last twenty-four years and I think it is quite correct to say that the edge of the valley marks the end of the tillable land—and it is no such valley as we have here.

The new factory at Loveland, Colorado, northwest of Greeley, I feel satisfied will have a fortunate experience, and I have always believed that a sugar factory should be built there. I think that district can sustain several more factories as it is the oldest part of Colorado, thoroughly developed, with a plant in farm improvements and irrigating canals of extreme value. There must be something in the climate of these elevated and dry regions favorable to a high sugar content, and we may well wish them success. They are buyers of our corn and we have every reason to desire to see them build up and prosper.

In the report of Prof. Wiley on beet culture for the year '97, reference is made to the climate of Nebraska that indicates his belief that our conditions are not as favorable as those in some other states. I had some correspondence with Prof. Wiley at the time, saying that while his remarks as to our very variable climate were true, there were also things that are true that he did not say, and speaking for our own district in Nebraska I assured him of my positive knowledge that our conditions are satisfactory; and as to other portions of the state my belief that in various places are districts of beet growing territory. Any of us knows of carload shipments of beets testing above 17 or 18 or even 19 per cent., and where this is true it appears to argue that something violent or crude or raw in our conditions of soil and climate produces inequality of sugar content that will disappear as beet growing becomes older and better established with us. Besides this, for a district as fertile as this entire portion of the state the average size of farms is too large, and there are too many very large farms. The great fertility of this part of the state is evidence that it is destined to be the home of a dense population, and it is only a question of time when this population will be living here. Therefore we are really in a state of readiness to bring about gradually the subdivision of the larger pieces of land, and the growth of the sugar industry and the diminution of the size of farms, which really belong together, will take place at the same time. The small size of farms in Michigan aided the growth of sugar production, because a state of things existed before it came which really needed sugar production, and they find that it meets a long felt want. While this is not true of Nebraska and the subdivision of farms has not yet taken place, conditions are

ready for it and people who need the land are waiting for it.

The average Nebraska farmer and well-to-do proprietor who is doing a successful live stock business is not impelled by any necessity to grow beets. There is not a farmer in the state who might not engage in it with profit to his business and benefit to his farm, but there is no use in expecting to find in him the natural agent for growing beets that we find in the case of poor people with large families, who expect to make a living by tillage of the soil. For the farm tenant growing beets is a very different proposition from that of the farm proprietor, and many farmers' sons must of necessity begin life as farm tenants, on the road to becoming farm proprietors, if they wish to follow agriculture at all. These have to pay over to some one else for rental a portion of the fruits of their labor, and the common crops grown in this vicinity do not leave a very large clear margin of profit out of which rental may be paid, for the very good reason that all these products are raised in great abundance beyond the necessities of home consumption, and are sold at prices that are fixed by open competition on markets that are always abundantly supplied. Our products are not only raised greatly in excess of our wants, but must find a foreign market in competition with those of other sections of the world. With sugar it is not only an entirely different thing, but exact opposite of this, and it is our market that foreigners desire to get. Under our laws this foreign product pays a duty, which in combination with the very small portion of our consumption furnished by domestic sugar, holds the price of sugar at an artificial figure which makes it possible for every one concerned in its production to get a much better reward than he can secure in the case of all other farm products that must seek a foreign market.

I believe that the hog has altogether the largest share n building up the solid improvement and prosperity of the northern portion of the Mississippi valley, including that of the Missouri, because of our extraordinary facilities for breeding swine and the small element of danger in this branch of business. Speaking of other farm products, it is no doubt true that a man may *save* a profit, but it is rather difficult for him to *make* it.

For reasons given above, therefore, farm tenants and farm laborers will find a far better reward by engaging in

the culture of beets than in any other branch of farming; and for this reason, and because we have the land and the fertility, we have, I believe, conditions favorable to making Nebraska the seat of great sugar production, to the vast benefit of her citizens. And a very reasonable amount of state pride should make strong in every one of us the resolution to see our own state put her best foot foremost, or at least not see her outdone by any other state with no better facilities. I fully believe that Nebraska is at the beginning of a new career in sugar production that will be one of steady and successful progress. In order that I may not be suspected of "talking through my hat"—as the expression goes—I desire to say that the strongest reason for making this assertion I find in the genuine confidence and hopefulness of people who are renting our land for beet culture this year.

It will be noted in the foregoing argument that the value of sugar production to the community is based on a price of sugar that is sustained by the duty on sugar under the Dingley law. You will remember that in the last few days of the expiring term of General Harrison—the beginning of March, '93—the annexation of the Hawaiian islands was almost accomplished, but not quite finished, and in that state the question was passed over to Mr. Cleveland, who completely changed the purpose of his predecessor. As to the effect on the price of sugar by the annexation of the Hawaiian islands, it was said that this sugar had come into this country free ever since 1875, and that it could not be claimed that their annexation was a sugar question. When the matter was revived in '97 annexation was resisted by many persons in the United States, on many grounds, and naturally among others by those interested in domestic sugar production. This resistance gained strength during the winter of '97-'98 and annexation was naturally killed and practically had to be abandoned. At this very moment, however, the sinking of the Maine brought on the Spanish war, and in June the question of annexation was quickly revived and passed as a war measure. The immediate effect was the creation of new sugar companies in the Hawaiian islands an era of great speculation in the shares of both new and old companies and a general boom and excitement in sugar properties. This told the story as to whether the annexation of the Hawaiian islands was a sugar question, not-

withstanding the fact that their sugar had come into the United States free ever since 1875. It was stated that Hawaiian exports could not increase on account of the narrow restrictions of the area that can be given to sugar production, but the industry gained great impetus, notwithstanding, and is still expanding.

The next thing to come up was the Porto Rican law followed by the case now pending in the supreme court to test the constitutionality of the said law. The exports of Porto Rico have been for many years about 50,000 tons, that is, about twice the product of the state of Michigan for 1900. Americans are investing in plantations in Porto Rico, and it is believed that their exports will expand considerably—some people claim to as large a figure as 300,000 tons a year.

Next come the Philippine islands with annual exports of about 150,000 tons of sugar. The expansion of sugar production in the Philippine islands, under a good government, may of course be very great indeed, and a decision concerning the duty on diamonds brought from there, now pending in the supreme court, will settle the status of these islands. Eighty-five per cent. of the duty on Porto Rican sugar was taken off in the Porto Rican bill, leaving a mere shred of duty which amounts to nothing; and if the same should be ruled with regard to the Philippine islands, another great quantity of cane sugar would have free access to this country.

Next comes the question of Russian countervailing duty, even now but recently brought forward by the re-imposition of a countervailing duty by Secretary Gage. Next comes the reciprocity treaties with British West Indies and British Guiana, granting a reduction of 20 per cent. on duties into the United States, in return for concessions on American products and manufactures.

Last, but most important of all is the Cuban question, which is indeed a sugar question, but which is such a household word with every one that it is unnecessary to say more than to mention it.

Here then is an enormous bulk of cane sugar—with the exception of Russian sugar, which is small in quantity—from points outside of the United States trying to find a market by concession in tariff in the United States, where the consumption is the greatest in amount, and perhaps

even per capita, of any country in the world, regarding which I quote the following from a recent issue of a French paper:

"If the consumption of sugar is practically stationary in France, on account of an excessive tax, and perhaps secret competition of artificial sugars, it is far from being so in the United States of America. From annual statistics that have just appeared we learn that during the past year the United States absorbed 2,219,847 tons of sugar, as compared with 2,078,000 tons in 1899, (these are metric tons to which one-tenth must be added, making our consumption nearly 2½ million tons). This is an increase of more than 140,000 tons, or of 6.82 per cent. over last year. Compared with what it was twenty years ago, the consumption of the American Union indicates an increase of 123 per cent., or of 6.34 per cent. per annum. At this figure, in twenty years in the United States, which will contain 100,000,000 inhabitants, instead of 76,000,000 of today, the consumption will not be less than 4,850,000 tons of sugar. Here then opens a brilliant perspective to the producers of Cuba, Porto Rico, Hawaiian islands, Java and to the manufacturers of beet sugar of North America, upon whom will devolve the exclusive care of securing a provision of sugar for this vast market.

"It is not only to the development of population that is due the remarkable increase of sugar consumption in the United States, it is also due to the increase of the public wealth. For this reason the figure of annual consumption per capita, which was 51 pounds in 1884, is increased to 66.6 pounds in 1900. Actually the United States are the greatest consumers of sugar in the world. Their consumption joined to that of the United Kingdom, which is more than 1,500,000 tons, absorbs nearly 40 per cent of the universal production of the world, now figured at 9,375,000 tons. One sees the preponderating influence of these two powerful consumers on the entire sugar markets of the world, and this influence can only increase, if it is not soon offset by European consumption. There is only one means for old Europe to escape in part the influence of the United States (as to countervailing duties) and that is to consume a larger portion of her own products; but this is only possible on condition of reducing the internal revenue tax on sugar, and making large reductions—this means real reduc-

tions and not the displacement of taxes like that effected by the recent law on liquors."

I have not mentioned several other countries—Danish America, Argentine, Guiana, etc., with which reciprocity treaties have been discussed, but suffice it to say that the total amount of cane sugar on which duties have either been remitted altogether, or may be reduced, bears a strikingly large proportion to the total volume of American consumption. In fact, only some European beet sugar and sugar cane from the East Indies and some other countries will remain as to duties as intended under the Dingley law. Each proposition to reduce duties naturally finds many American sympathizers. The manufacturers of various products of steel, wool, leather, cotton, etc., are looking out to increase their sale, which is perfectly proper, and in order to do so recommending a reduction of sugar duties, in order that sugar may come in more freely from countries where they sell their products, and in consequence the volume of their sales increase. This is also quite proper, as we expect any business man to look after his volume of sales, or any other point that concerns his business in every way that is honorable; and there is nothing dishonorable in a shoe manufacturer requesting a reduction of sugar duties. This is no reason, however, why the citizens of Nebraska who wish to produce sugar from beets grown on Nebraska farms should aid shoe manufacturers, or any other manufacturers, to increase the sales of the things they make to the injury of Nebraska farmers. Within the last week, or two weeks, Chicago manufacturers of agricultural implements were quite excited over the acts of DeWitte, Russian minister of finance, in retaliating for our countervailing duties by placing an extra duty on some of our products. It turned out, if I am not mistaken, that agricultural machinery was not affected by the orders of DeWitte, but even if it had been, I do not see why agricultural implement manufacturers may not as well sell sugar beet machinery to Nebraska farmers as reapers to the Russians—but then manufacturers of reapers are not the same persons perhaps as the manufacturers of beet machinery.

All this gives an idea of how well these other people are looking out for themselves, and it behooves us to take a leaf out of their book and in our turn keep an eye on our own Nebraska interests. The domestic sugar interest of

this country are beginning to see these facts, and public opinion is being built up that will resist the sacrifice of our possibilities in domestic sugar production, for the purpose of letting in cane sugar at reduced duties in order that larger exports of certain manufactures may come about.

Anyone who reads the papers, therefore, knows that this is a critical time; that there is a very great change in the situation of domestic sugar production since the spring of '98; and that the sugar producers of the entire world are straining every nerve to get possession of our markets by the abolition or reduction of sugar duties. The aggregate of all the sugar that has of late been making such attempts is very great; importations from British Guiana, San Domingo, British West Indies, Porto Rico and the Hawaiian islands being nearly 550,000 tons, or one-fourth of our total consumption. The crop of Cuba for the present year is about one-fourth of our present consumption—the two together making about one-half our total consumption. If sugar from the Philippines should come in free, that would be added, making over one-half our total consumption.

The countervailing duty on Russian sugar has been retained, but if its collection had been waived by the government of the United States, other European countries on some pretext or other would have demanded that their countervailing duty should have been suspended also. You can easily see therefore that the rate of duty is under discussion on enough sugar to break our market badly if these concessions should be granted. Some decline in the price of sugar will take place, in any event, but if you feel convinced, as I do, that sugar production is the opportunity of Nebraska, and the hope of our own state, you will join in the demand that our expectations shall not be bartered away to serve the interests of some other persons, until it is so clear that it is right to do so that we concede it ourselves.

We have here no mines nor forests nor possibilities for the manufacture of fabrics, steel and leather products. There is no reason, however, why we should not make sugar, and in this find recompense for our limited possibilities in other directions.

Mr. Allen after reading his paper presented the following resolution to be voted upon:

Whereas, the production of sugar from beets may, if

protected, develop into one of the most important industries of our country, and of this state and locality, and

Whereas, we are by natural causes debarred from foreign commerce, from many lines of manufacture and other activities possible elsewhere,

Therefore, we demand that our opportunity to establish an industry of incalculable value to our growing population be not impaired by the withdrawal of promised protection.

Some difference of opinion existed as to the meaning of the words "promised protection" which Mr. Allen construed as protection sufficient to maintain the industry. After considerable controversy and a third reading of the resolution a vote was taken which proved unanimous.

HOW MANY TIMES SHOULD BEETS BE HOED.—J. DUGGLEBY.

This question is very hard to answer, as much depends upon the kind of ground in which beets are planted, and whether it is foul or clean.

On ordinary ground I think one hoeing is sufficient about two weeks after thinning, after which it is only necessary to keep the weeds from growing between the beets. I think foul ground, especially that in which there is a great deal of foxtail, should not be used for beets, as the expense of preparing it will more than offset the profit.

Hoeing beets is very tedious work and in order to get all the weeds, it is necessary to stoop down and pull them out with the hand, as this cannot be accomplised with a hoe without cutting out a great many beets, which fact may be proved by following the hoer and noting the number of wilted beets that have been destroyed.

My idea of raising beets is that little, if any, hoeing should be done. If bunching and thinning have been properly done, and the cultivator has been running close to the beets, there will not be very many weeds, and I would suggest that to remove these children from twelve to fourteen years should be employed. Even if it is necessary to go over them twice in this manner, it will prove a cheaper method than hoeing, as aside from the destruction of beets, the wages of the men employed for hoeing, will be much greater than those of children. I have seen beets that had received no hoeing after bunching, which at harvest time were just as clean as fields that had been hoed twice, and which were as rich in sugar and furnished as good a tonnage.

In conclusion I would say: Keep your beets free from weeds up to harvest time, and do it without hoeing, if you can. Hoeing should be used as a last resort.

Mr. Grigereit expressed doubt as the advisability of hoeing. He did not agree with the German who believed in his ability to hoe sugar into beets. Mr. Scilley was of the opinion that it would be impossible to dispense with the hoe altogether, and a second hoeing is sometimes advisable.

HARVESTING AND SILOING BEETS—THOMAS PECHA.

The time of harvest is governed by the maturity of the beets, which is indicated by the outside leaves of the plant taking on a yellow tinge and dropping to the ground. An experienced eye soon learns to detect a field of ripe beets and to know when they should be harvested.

As beets increase very much in tonnage during the month of September and the early part of October, harvesting with full force should not begin before the middle of October. The plowing out of beets is done with a two-horse puller, which loosens the beets, but leaves them in the ground. After this the beets have to be pulled by hand and topped with a corn knife at the base of the first leaf in order to remove the entire stalk. It is necessary that this work should be done with great circumspection, as this portion of the beet is rich in salts, which though worthless to the manfacturer is of appreciable value to the farmer as a stock food.

Considerable experience is needed to know just when to put the beets in silo. It is better to select a very dry day. Beets that are siloed when wet in most cases undergo fermentation. On the other hand, if exposed too long to the sun, the roots shrink and there is a sacrifice of weight. In an average season no beets should be siloed before the middle of October, and if the weather is warm it would be better to wait until the 20th. However, in no case should the beets be allowed to remain unharvested until the ground freezes. Frost bitten beets will not keep, therefore all beets put in silo must be free from frost and they should in order to avoid danger, be covered the same day they are harvested. There are different methods of siloing beets, the one most commonly practiced being that of placing beets in long piles on the surface of the ground. Never select a wet spot nor one where the water is liable to settle during rainy weather. The base of the silo after the surface has been leveled should

be about four feet wide and the height three feet, tapering toward the top. Beside each pile of beets several furrows should be made with a stirring plow in order to loosen the dirt. With this dirt the silos should be completely covered to a depth of about six inches, occasional air spaces or ventilators being left at the top, for which purpose small elongated wooden boxes are often used. Otherwise an opening of a foot in diameter may be left at the top which should be covered with dirt as soon as the temperature of the silo becomes too low. In case a person is unable to follow these suggestions before cold weather comes on, he should cover the silo with straw and later add dirt. Silos should be watched carefully and opened occasionally for inspection to see if there is a tendency to heating.

It is generally advisable not to put more than six inches of dirt over beets in October, though this depends, of course, upon the weather. Silos should be covered before hard frosts with five or six inches of good straw, leaving the ventilators uncovered, over which should be placed two inches of dirt to prevent the straw from blowing away, and for the purpose of packing it, as packing will keep the cold air from entering the silo. As soon as the covering freezes two inches, close the ventilators with dirt and keep them closed.

In conclusion I would say that in the minds of many people there appears to exist an opinion that some peculiarity of climate interferes with successful beet growing in Nebraska, and I have often heard the statement that beets cannot be grown here as well as in Germany. I believe if someone would go to Germany for the purpose of investigating this point he would find that this is a mistake. To substantiate this statement the argument is used that Germany is no corn producing country, and naturally a corn producing country such as Nebraska must possess very different conditions of climate. However, the prairie regions of Hungary, Southern Russia and Bosnia produce quantities of corn, and at the same time the beet industry has gained great prominence in these countries.

The Dakotas and Manitoba are noted wheat producing countries, although very often there is a total failure of the crop there. Nothing strange is thought of this, but if a failure of a beet crop occurs in Nebraska on every hand we hear the suggestion that the climate of the state is not suited

to beet growing. This seems to me a very narrow and ill founded opinion

Mr. Scilley had kept beets until June that were as sound as when they were put in silo. If beets mature properly they do not suffer deterioration of sugar content. Last year out of 670 acres put in silo only one or two silos showed signs of spoiling. There is a decided advantage gained by siloing, as harvest advances much more rapidly at a time when help is scarce and beets can be hauled to the factory as well later in the season.

Mr. H. Scilley emphasized the necessity of care being taken that beets should not be bruised when put in silo. An entire silo may sometimes be spoiled, as the effect of fermentation caused by the bruising of a small number of beets. Beets should not be topped too close. It is better to run the risk of a heavy tare than that loss of sugar should be sustained by fermentation.

THE BEST KIND OF HELP FOR A BEET FIELD AND HOW TO HANDLE IT.—A. S. GRIGEREIT.

In speaking of the sugar beet industry we come at once face to face with the fact that here we have an agricultural pursuit which differs materially from any other practiced in this part of Nebraska. First, that it requires an entirely different preparation of the soil, and a higher state of cultivation than ordinary crops; and second that it is an industry where every member of the family who is old enough or sufficiently strong to do manual labor may be profitably employed. For example, the farmer with a family of from four to six children, ranging in age from eight to sixteen years, be they boys or girls, may employ them all in a profitable and healthful manner for several weeks during the school vacation; while to people of small or moderate means, living in a city or village near which beets are raised, it is a positive boon. Not only does it furnish employment, thus keeping boys and possibly girls, out of mischief, but furnishes a source of considerable income, as well as overcoming the evil effects of nine months of close confinement in the school room without proper exercise.

Perhaps some will object to the statement that it is a healthful employment, as we sometimes hear people complaining of the children having to be out in the hot sun. Is

it not true that many children suffer more from a lack of sunshine than from too much of it? Is it not also true that many of the boys and girls of certain classes would be as constantly exposed to the sun, if left to their own devices, without receiving the benefit of the discipline connected with labor and of the money they receive? To be sure there are a few days in summer when the heat is intense, but it is seldom necessary for them to be exposed on such days.

In dealing with the subject given me it will be necessary to divide the year's work into different classes. First, the preparation of the soil and planting: For this work good men with good teams are required, unless, as often occurs, cornstalks are to be removed, in which case children may be employed to good advantage. Every farmer realizes the advantage of a good strong team, but even a good team is worthless without a good driver who understands and is willing to follow instructions carefully.

Following closely upon preparation of soil and planting comes what may be termed the main work of the season—tending the growing crop, in which all members of the family may be employed. The cultivating of necessity will be done by men, and bunching is usually considered men's work, though it may be equally well done by women or children, provided they are careful, as this is one of the most important features of work connected with the industry.

For weeding and thinning children are preferable; not only will they do it more cheaply, but being nimble they can do the work more easily. Though they do the work more cheaply than men, many children make very good wages. In my own experience I have known boys who made from $1.00 to $1.40 per day when working by the row or the acre. The majority, of course, make much less, though what would still be called good wages.

I would not advocate having work done by the row or acre, as it is not always easy to find those who are sufficiently trustworthy to be allowed that privilege; but one is sometimes found who, stimulated by the chance to earn extra wages, is willing to put forth the extra effort needed. When such are found I deem it advisable to grant them the privilege with the understanding that they lose it as soon as their work proves unsatisfactory.

This brings us to the harvest which again offers opportunity for women and children to be employed, since aside from the plowing out, hauling and siloing, all may be done by them. It might be well to mention that in the harvest there is even greater opportunity for energetic workers to make extra wages working by the row or acre, as it is not so difficult to oversee such work in the harvest as during the weeding.

In introducing the second part of my subject I wish to state that there are as many ways of handling help as there are persons who have help to manage. The successful leadership of others is a subject too broad and deep to be treated in a paper of this nature, and belongs rather to psychology than beet culture. It has been said that poets are born, not made, and history has shown that great leaders may in this respect be classed with poets While it may sound somewhat ludicrous to class overseers of help in beet fields with generals and statesmen, still the more natural leadership a man possesses, provided he uses it modestly and not in an overbearing manner, the better he will succeed.

People, especially children, are quick to detect weakness or strength in an employer and are quite likely to govern themselves accordingly. These are simply facts and should be borne in mind as we proceed. Happy indeed is that man who has the natural faculty for overseeing the work of others, in whatever capacity he may be employed.

Since most of us who have help to handle belong to the class who must study the subject carefully, it is from this standpoint that I shall make a few remarks on the subject.

First, I would state that it is well in hiring help to have a thorough understanding. Leave nothing to be settled afterwards, as such bargains are usually unsatisfactory and nothing will be lost by frankness.

If the pay is to be proportionate to the work performed, or if the right is reserved to dismiss workers on account of poorly performed work, instruct people to this effect when they are hired, as it may avoid much trouble. If the wages are to be stated, tell them the exact amount they may expect—not *about* so much. Have few rules and let them be short and concise, and let each one hear them directly from yourself. If you make a statement, live up to it, though it may cost you your best hands. However, it may be well to

elaborate a little on this point: Possess yourself in patience. Never make a statement in anger, as it then becomes a threat, and threats never accomplish a desired end. Your help will realize that you are angry and threatening before you do. Great patience and tact are needed, and thoughtful care in making verbal promises.

Be constantly on the alert for badly performed work, and find it yourself rather than allow some other worker to inform you of it. The work should be carefully inspected, especially that performed by children. Try to make them understand that you are only doing your part of the work and that you are not expecting something wrong.

I would not have it understood by what follows that I would turn the beet fields into a missionary field, but there are certain moral features which I consider are in place. I will tell you how I have managed and you may draw your own conclusions. I forbid cigarette smoking, swearing and vulgar and obscene talk. I have two principal reasons for this course. First, I do it from a business standpoint alone. A boy with a cigarette in his mouth will not work very rapidly. In fact he might about as well take his time and devote it to smoking as far as his value in the beet field is concerned. I have actually seen fields where half of the time was wasted in this manner, and yet full pay was expected. The vulgar and obscene language has a similar though worse effect, for instead of interfering with the work of a single person it stops the entire gang. They first stop to listen to it, then to laugh, and each one spends more or less time trying to think of something to add as his contribution, and before you realize it the whole gang is demoralized and must be put back to work. Children are like machines. It requires less time to keep them going than to start them when they come to a stop. An overseer who goes from one individual or group to another scolding and fretting wears himself out needlessly and loses the respect of help.

The second reason for practicing morality in the beet field is this: I have found many parents who were much more willing to allow their children to work in the field when they learned that vulgarity and obscenity were prohibited, and help was therefore more easily obtained. And then we would not entirely overlook the salutary effect upon the young people in question of having these vices

somewhat restrained. We may not hope to do much toward reforming this class, but it is the positive duty of every individual or organization employing labor to raise rather than lower the standard of those employed.

One more thought along this line: It is better so far as possible to have boys and girls work in separate gangs. More and better work, I believe, will be the result.

In weeding and thinning I should say that one man can oversee from twenty to twenty-five workers. I have managed from thirty to thirty-five, but this is rather too large an undertaking.

There is one habit to be guarded against more than any other; that of breaking the top off the weed rather than pulling it up by the roots. This not only is without value, but is a positive detriment. The roots take a firmer hold and when they send up new tops they grow with double vigor, and are much more difficult to remove at the next weeding.

This paper has been prepared from the standpoint of raising beets on a large scale near a city or town where hired help has to be depended upon entirely. Consequently, what has been suggested as to the management of help would not apply as a whole to the farmer who raises but a few acres of beets and depends upon his own family to do the work.

THE COMPARATIVE VALUE OF HIGH AND LOW GRADE BEETS.—R. S. BULLA, ASS'T SUPT. STANDARD BEET SUGAR CO.

This subject is doubtless intended to refer directly to the use of beets in the factory, though it naturally applies more or less indirectly to their value to the farmer as well. An explanation of the reason why a beet of certain sugar and purity is worth a certain price, and another of the same sugar, but lower purity, is worth less to the buyer, is the object of this paper.

The question of sugar content is readily understood by anyone at all conversant with the growing and handling of beets. A contractor knows at once that a beet with 10 per cent. sugar is worth less than one containing 12 per cent. He can easily understand that a sugar company cannot afford to pay as much for the 10 per cent. beet as for the 12 per cent.

one, because he can easily compute the theorctical amount of sugar contained in both. In the first he finds that there are but 200 pounds of sugar per ton, while in the second he finds 240 pounds. That is to say that the 12 per cent. beet contains 40 pounds more per ton than the 10 per cent. beet. It is therefore assumed that there is no confusion in the minds of beet growers in regard to the sugar percentage and what it means. The question of purity coefficient has always been eyed with suspicion by those contracting for growing beets under the ordinary form of contract heretofore in vogue. It may be well at this point to explain what is meant by the term and how it is obtained from an analysis of beets.

Suppose a beet has been found to contain 12 per cent. sugar and to have a purity coefficient of 80 per cent. What does the 80 per cent. represent, and why should it have an effect upon the price paid for beets? The sugar is found by direct polarization of the juice pressed from the sample of beets analyzed. This disposes of the sugar per cent., and if nothing further were required would complete the analysis. However, if it be desired to find the purity, it is necessary to carry the analysis further. If in the case above, the sample of beets were dried to a point of absolute dryness, and the resulting dry matter polarized, it would be found to contain 80 per cent of sugar, or in other words that the total solid matter is 80 per cent. pure in terms of sugar. However, in practice it is almost an impossibility to find the total solids by the evaporation of moisture. Some other method, more rapid and still not so susceptible to the numerous errors that may occur in the preceding method, unless carefully carried out, must be found. The specific gravity of the juice pressed from the beets may be taken and from this the purity may be calculated. This method depends upon the fact that a solution of pure sugar of any given density always contains a per cent. of sugar corresponding to that density, this per cent. being unchangeable. It is therefore possible to make an instrument that will read directly the sugar per cent. of any pure sugar solution. Such an instrument is called the brix spindle, or the brix hydrometer. It is evident that a solution of common salt may be read in the sugar per cent. by such an instrument, but that is not saying that there is any sugar in the solution. It simply means that the salt solution of that density reads in

per cent. of sugar what a sugar solution would read of a like density, or that the salt solution has been read in terms of sugar per cent. Now suppose that the expressed juice from a sample of beets has been measured for its total solid matter by means of the brix spindle. It is not a pure sugar solution, but all the solid matter it contains is read as if it were all sugar. The question is therefore to find what per cent. of this reading represents the true sugar, and what the non-sugars. The true sugar by the polariscope has already been found to be 12.6 per cent. and the brix to be 15.7 per cent. If now the sugar per cent. be divided by the per cent. of total solids given in terms of true sugar, it will give a factor which represents the percentage of true sugar in the total solid matter contained in the sample of juice taken from the beets under investigation. This factor is the purity coefficient and in this case is 80 per cent. Thus in speaking of a beet as 12–80, it is meant that as it comes from the field it contains 12 per cent. of sugar, and that 80 per cent. of its total solids is sugar.

In the foregoing may be found a method for determining the relative value of beets of high and low purities. In the case of beets containing 12 per cent of sugar and having a purity of 80 per cent, the brix, or per cent of total solids, must be necessarily 15 per cent, or 300 pounds per ton of beets—this regardless of pulp. At 12 per cent the sugar is 240 pounds per ton; the excess of total solids over the sugar is 60 pounds, or 25 per cent of the sugar. This excess is generally termed the nonsugars, and consists of those substances that are detrimental to the production of sugar. In a beet of the same sugar, but a purity of only 65 per cent, the brix is 18.4 per cent, making 368 pounds of total solid matter per ton, an excess of 128 pounds of total solids over the sugar, or 53.3 per cent. In the first case there were 60 pounds of matter to get rid of to recover the possible 240 pounds of sugar, while in the latter case there are 128 pounds, a difference in favor of the higher purity of 68 pounds, less nonsugars, to handle. This means that in a factory of 500 tons daily capacity, with 120,000 pounds of sugar entering, it requires the working of 34,000 pounds more matter to secure it. The nonsugars are the molasses forming properties and pass into the last products of the factory in the shape of molasses

Beets of 80 per cent. purity mean really by the time

the purification by means of the lime has taken place, a purity of the product at this stage of about 87 per cent. Therefore, a ton of beets may be represented by its equivalent purified product having a purity of 87 per cent, the difference of 7 per cent. in purity having been accomplished by the lime. All the nonsugars now represented in the product at 87 per cent. will be found in the molasses. In the case of 12 per cent. beets then, having a purity of 80 per cent. when analyzed, and afterwards brought to a purity of 87 per cent, there will be 90 pounds of molasses made per ton, or 45,000 pounds per day of 500 tons. Of this molasses, about 52 per cent. is sugar, representing 23 400 pounds unrecovered, unless by the aid of some other process. In our factory at Ames and in two or three other factories in this country, about 66 per cent. of this is saved by the use of the Steffen's process, leaving only about 8,000 pounds unrecoverable.

Taking now the case of the low purity beets, and applying the same calculations, the difference will be readily seen. At 12–65, there will still remain the same amount of sugar entering, but the total nonsugars will be increased to 128 pounds per ton of beets. By the purification process we raise this purity to 74 per cent. so that the ton of beets may be again represented by its equivalent purified product as 12–74. There will then be 150 pounds of molasses per ton, or 60,000 pounds per 500 tons, representing 31,200 pounds of sugar. Recovering 66 per cent. of this by means of the Steffen's, there will still remain 10,700 pounds unrecoverable, or a difference between a run of 500 tons of 80 per cent. beets, and the same amount of 65 per cent. beets of 2,700 pounds in favor of the higher. The percentage of loss in the molasses alone in the first case is .66, while in the second case it is practically .9.

So far only beets with 12 per cent. sugar have been considered. If beets of 10–80 are taken, and results calculated as before, they will be found to make 62.5 pounds of molasses to the ton, or for 500 tons 31,250 pounds, of which there are 5,525 unrecoverable, representing a loss of .52 per cent. Again taking the same sugar but a purity of 65 per cent. and once more applying the same calculations as before, there will be found to be 87.5 pounds of molasses per ton, or 43,750 pounds per 500 tons, making a loss of 7,750 pounds of sugar, representing .77 per cent. Therefore the

lower the purity, the greater the loss in molasses and the more sugar unrecoverable.

So far only the effect upon loss in molasses has been spoken of and we have taken up only the question of purity in our consideration of low grade beets. However, it must not be forgotten that when low grade beets are spoken of the sugar is also to be considered. As a matter of fact, it is almost invariably the case that when the sugar is low we find a low purity as well. It costs as much to run a factory working 10 per cent. beets as it does when working 12 per cent. beets. With high sugar and high purity the capacity can be much more easily maintained than when working low grade beets, from the fact that the excess of total solid matter to be gotten out of the way with the low grade beets is so much greater. If there is the same amount of non-sugars in 450 tons of low grade beets as there is in 500 tons of high grade beets, then the factory on the low beets can not run to its capacity, while the cost of running is practically the same for the smaller capacity as it is for the greater.

In addition to his paper, Mr. Bulla had been requested to furnish something on the subject of manufacturing alcohol from agricultural products. He was unable to find anything directly bearing upon this point, but he read a very interesting extract from a leading French journal, as follows:

In an extract from an editorial by Georges Dureau, in Le Journal des Fabricants de Sucre of January 23rd, we find this:

"We report at this time an interesting conference which was held last November before the committee of Magdeburg and vicinity, by Prof. Dr. Wittelshoefer, a member of the Central Association for the use of alcohol in Berlin. * * * The German distilleries produce from 370 to 380 million litres of pure alcohol a year. How is this amount disposed of? The exportation, never flourishing, absorbs about 23 to 25 million litres. On the other hand, the industries and beverages consumed last year about 105 million litres. Of this quantity, the production of vinegar used 17 million litres, the chemical, pharmaceutical, and the manufacture of smokeless and odorless powders consumed about 20 million litres. But the largest portion of alcohol and the spirits of wood found employment in heating, lighting and in use as power. In order to arrive at these results, it is

necessary to regulate the selling price of alcohol to patrons. It is not necessary to make the statement that an alcohol motor should be bought, for example, to pay at the present time three times as much as will be necessary three months later, and the same inconvenience should be avoided in the case of heating and lighting. This problem has now been happily solved by the German distillers for a period of nine years. The Central Association, established by the distillers for the employment of alcohol disposed of the larger part of the alcohol not destined for consumption as beverages. They have been able therefore to regulate the selling price and to supply the markets for the furnishing of alcohol at a fixed price for a period of nine years.

The Central Association has closed a contract with the city of Magdeburg for the furnishing of alcohol for more than a hundred lamps. All the alcohol necessary will be delivered at a fixed price unchangeable up to the year 1908.

Speaking of the employment of alcohol as a motive power, the orator said that all the German engine constructors have adopted for alcohol motors the primary types of gas and petroleum motors; the Society of Koerting Bros., the gas engine manufactory of Deutz, and the engine manufactory of Oberursel, have been able, by means of some slight changes, to adapt their engines to the use of alcohol. The alcohol is introduced into the explosion chambers only in a gaseous state. There are at present in actual use in Germany about sixty locomobiles operated by the use of alcohol. During the month of March, 1900, the factory of Oberursel furnished alone 43 or 45 locomobiles run by alcohol.

The alcohol locomobiles are especially demanded in agriculture. The alcohol motor has not the disagreeable odor usually found in those using petroleum, and for this reason they are very advantageously replacing the latter in the dairy industry. They work with much more regularity and economy in the consumption of fuel. One can count upon at most .4 of a kilogram of alcohol per horsepower per hour, or about .5 of a litre. The Central Association sells the alcohol at from 20 to 22 pfennigs per litre, making a cost, therefore of about 10 to 11 pfennigs per horsepower per hour. At this price, alcohol has the advantage of petroleum. At the present price of coal it competes very successfully with steam in traction engines for threshing purposes.

This economy is realized from the fact that it is not necessary to transport coal and water, and also that as soon as the motor is stopped the consumption of fuel ceases.

The Conference thought that alcohol motors could be used to advantage in agricultural pursuits, and there is at this time an alcohol locomobile being constructed, designed for that purpose, of from 50 to 60 horsepower.

In this connection the use of alcohol has already been adopted in Germany in many villages and railway systems. In the cities it is often advantageous to install alcohol lamps in the less populated districts distant from the center. The incandescent alcohol lamp renders a real service in this particular. The method of lighting is more economical than the incandescent gas lamp. The celebrated Helfft lamp burns one litre of alcohol in nine hours at a cost of 25 pfennigs per litre. This is an expense of about three pfennigs per hour, or four pfennigs per candle power per hour as against six pfennigs for petroleum; seven pfennigs acetylene; 1.2 pfennigs for incandescent electric light, and .9 pfennigs for electric arc light. Alcohol is therefore much cheaper even than petroleum.

The orator exhibited an alcohol lamp of from 30 to 35 candle power at a cost of two pfennigs per hour by the side of a good petroleum lamp of only 24 candle power All these lamps are used in the cities, and on farms, dairies and railroads. In terminating his speech Prof. Wittelshoefer shows some new apparatus for heating and for use in the kitchen by the use of alcohol."

Mr. Allen expressed interest in the paper read by Mr. Bulla and suggested that possibly low grade beets and other agricultural products might be used for the manufacture of alcohol. Mr. Hiltner produced some figures as to the relative heating value of alcohol and gasoline, and stated that unless the price of alcohol could be reduced to four or five cents a quart it could not compete with the products of the Standard Oil Company.

R. D. KELLY,
Secretary of the Farmers' Institute.

H. G. LEAVITT,
President.

R. M. ALLEN,
Vice-President.

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